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(12) **United States Patent**
**Moskowitz et al.**

(10) **Patent No.: US 10,610,371 B2**
(45) **Date of Patent: Apr. 7, 2020**

(54) **ARTIFICIAL CERVICAL AND LUMBAR DISCS, DISC PLATE INSERTION GUN FOR PERFORMING SEQUENTIAL SINGLE PLATE INTERVERTEBRAL IMPLANTATION ENABLING SYMMETRIC BI-DISC PLATE ALIGNMENT FOR INTERPLATE MOBILE CORE PLACEMENT**


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(21) Appl. No.: **15/870,406**

(22) Filed: **Jan. 12, 2018**

(65) **Prior Publication Data**

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**Related U.S. Application Data**

(63) Continuation of application No. 14/739,327, filed on Jun. 15, 2015, now Pat. No. 9,867,712, which is a

(Continued)

(51) **Int. Cl.**

***A61F 2/44*** (2006.01)
***A61F 2/46*** (2006.01)
*A61F 2/30* (2006.01)

(52) **U.S. Cl.**

CPC ............ ***A61F 2/442*** (2013.01); ***A61F 2/4425*** (2013.01); ***A61F 2/4611*** (2013.01);

(Continued)

(58) **Field of Classification Search**

None

See application file for complete search history.


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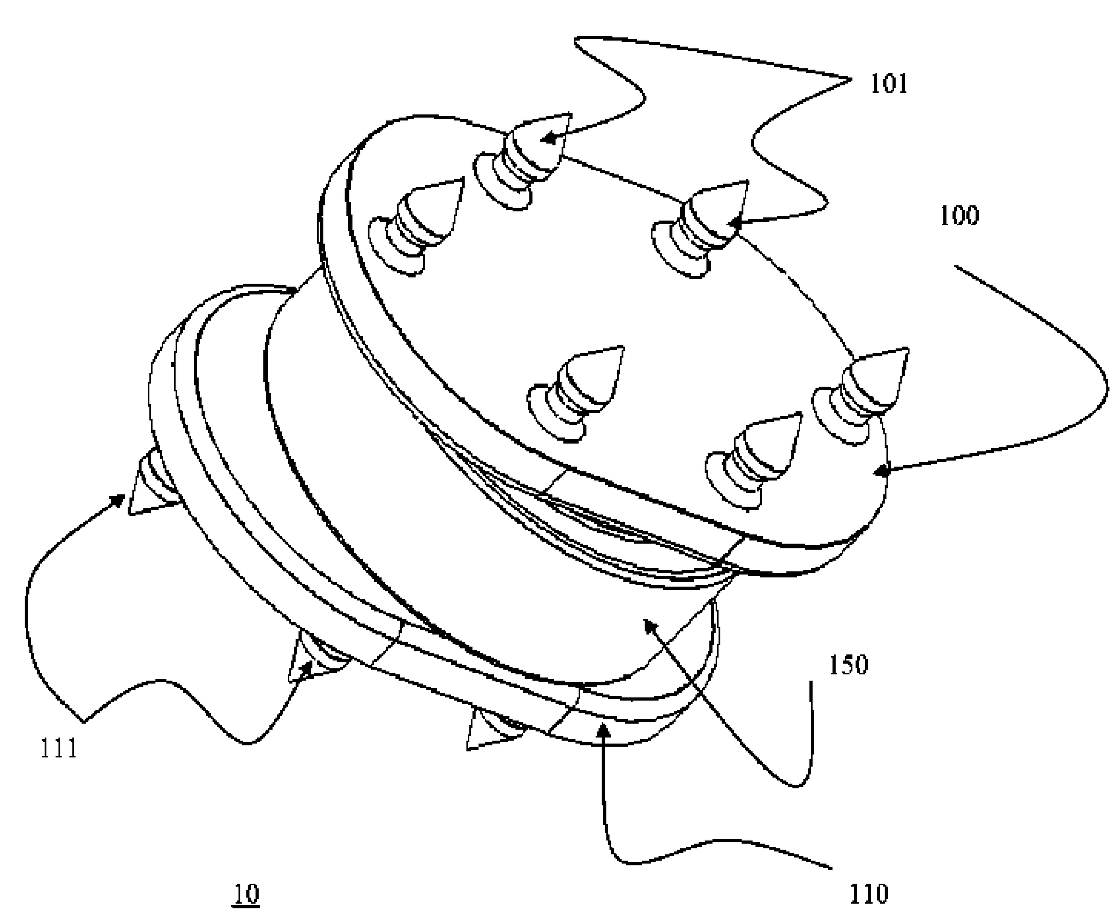
(57) **ABSTRACT**


An artificial replacement disc includes a pair of substantially parallel plates formed to occupy a space defined by vertebral endplates, each of the plates including a plurality of spikes on a first surface and a concave trough formed on a second surface opposite of the first surface. A mobile core includes a core rim with opposing convex surfaces extending from opposite sides of the core rim, the mobile core being capable of being disposed between the pair of plates to permit the vertebral endplates to move relative to one another. The spikes on each of the plates extend substantially away from the mobile core and the convex surfaces are formed to integrally fit within the concave trough of at least one of the plates. The core rim limits lateral movement of the mobile core relative to the parallel plates. One or more insertion tools for inserting and implanting the replacement disc are also described.


**15 Claims, 38 Drawing Sheets**



**Related U.S. Application Data**

continuation of application No. 13/893,326, filed on May 13, 2013, now Pat. No. 9,056,018, which is a continuation of application No. 11/943,334, filed on Nov. 20, 2007, now Pat. No. 8,535,379, which is a continuation-in-part of application No. 11/487,415, filed on Jul. 17, 2006, now Pat. No. 7,854,766, which is a continuation-in-part of application No. 11/019, 351, filed on Dec. 23, 2004, now Pat. No. 7,083,650, which is a continuation-in-part of application No. 10/964,633, filed on Oct. 15, 2004, now abandoned.

(60) Provisional application No. 60/788,720, filed on Apr. 4, 2006, provisional application No. 60/570,098, filed on May 12, 2004, provisional application No. 60/570,837, filed on May 14, 2004, provisional application No. 60/572,468, filed on May 20, 2004, provisional application No. 60/573,346, filed on May 24, 2004, provisional application No. 60/578,319, filed on Jun. 10, 2004.

(52) **U.S. Cl.**
CPC ............... *A61F 2002/30125* (2013.01); *A61F 2002/30604* (2013.01); *A61F 2002/30649* (2013.01); *A61F 2002/30662* (2013.01); *A61F 2002/30841* (2013.01); *A61F 2002/443* (2013.01); *A61F 2230/0008* (2013.01); *A61F 2230/008* (2013.01)

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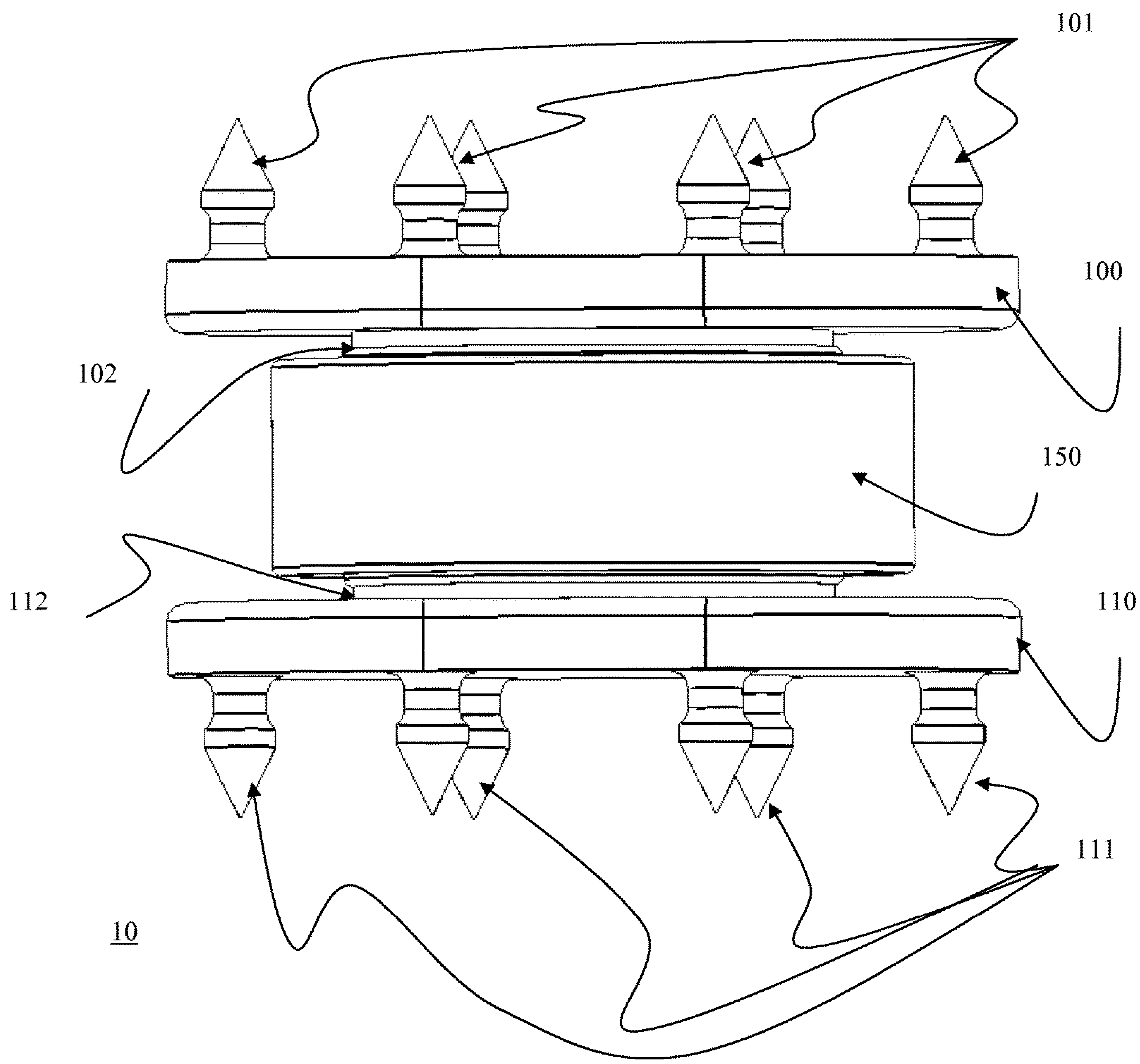


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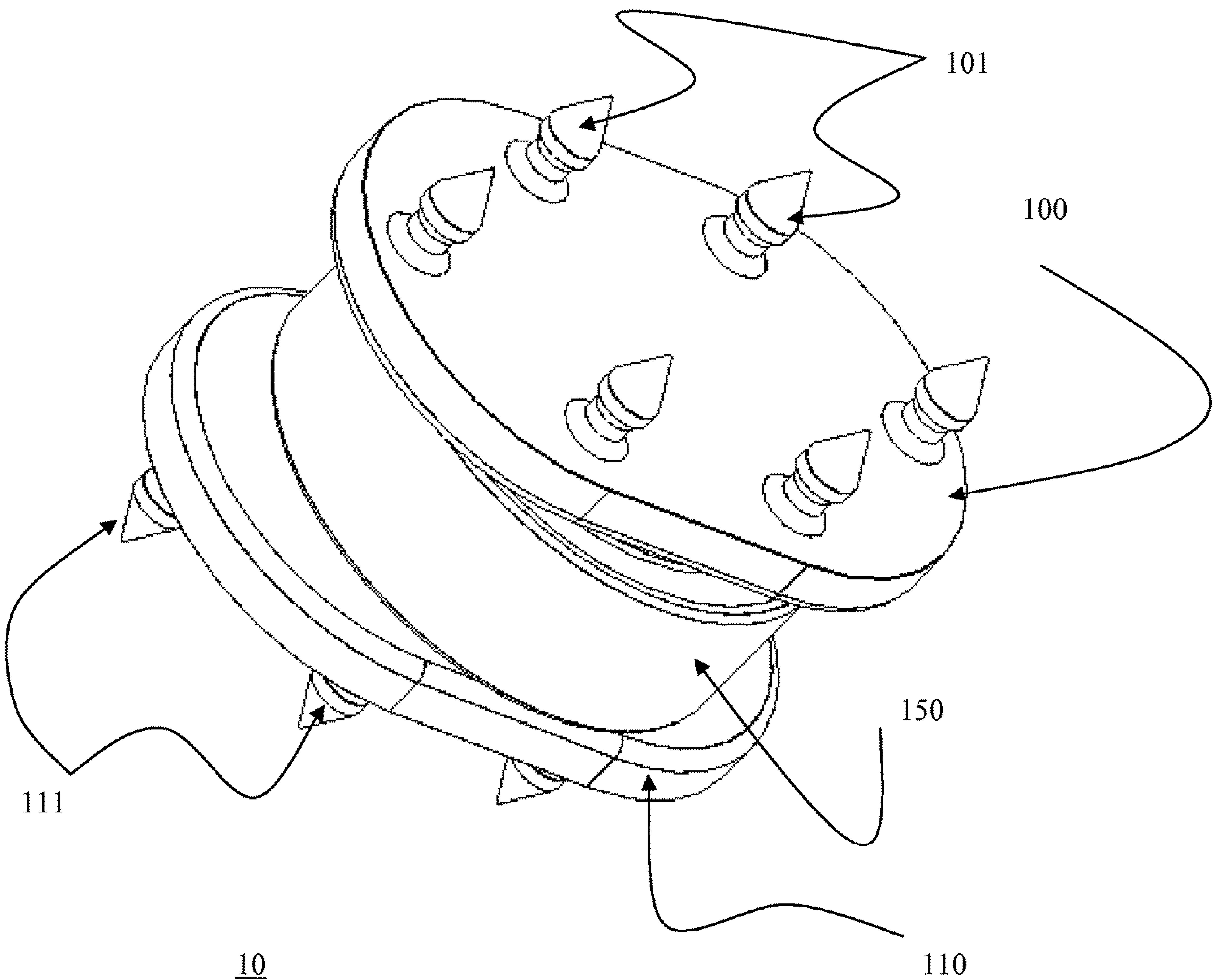


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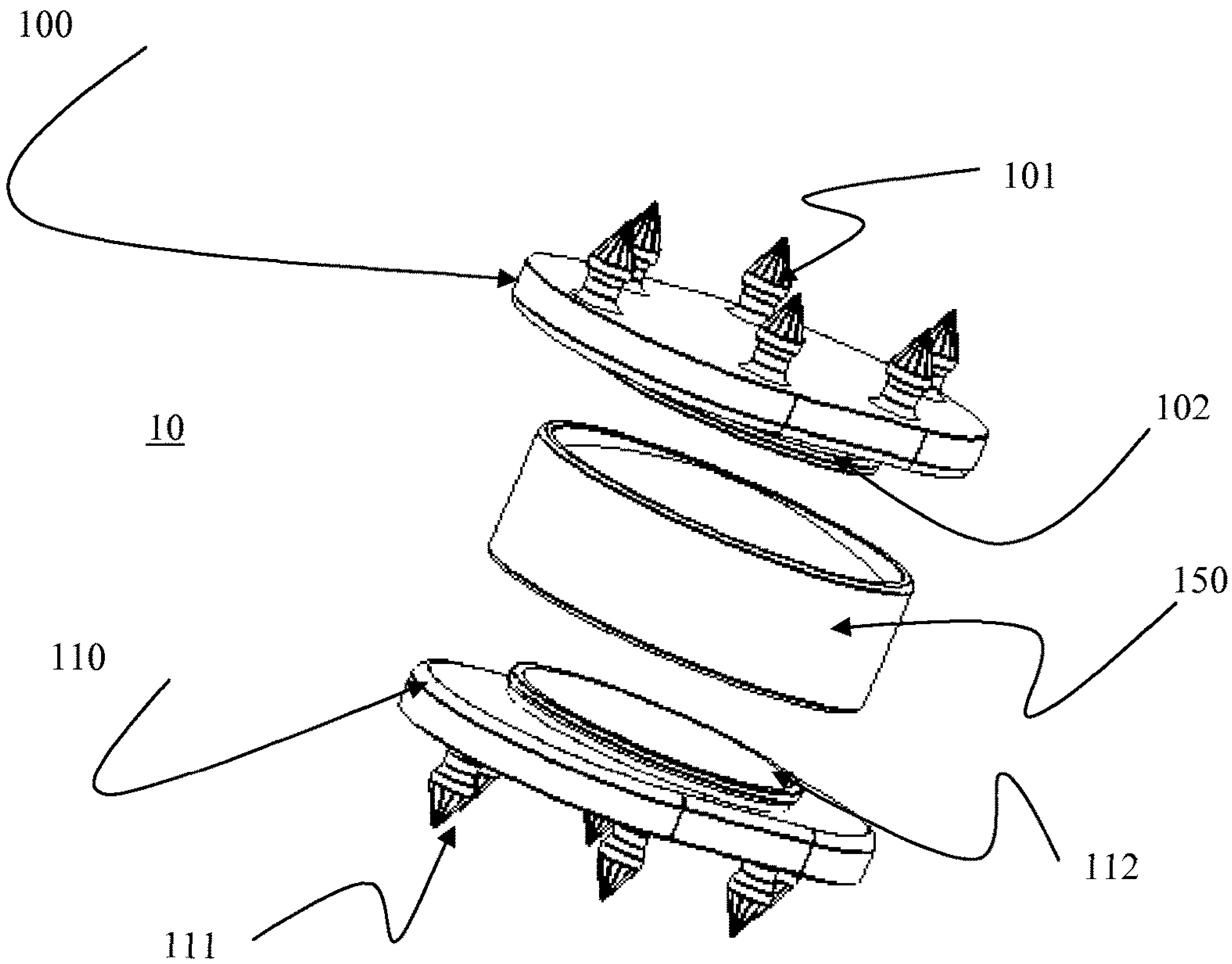


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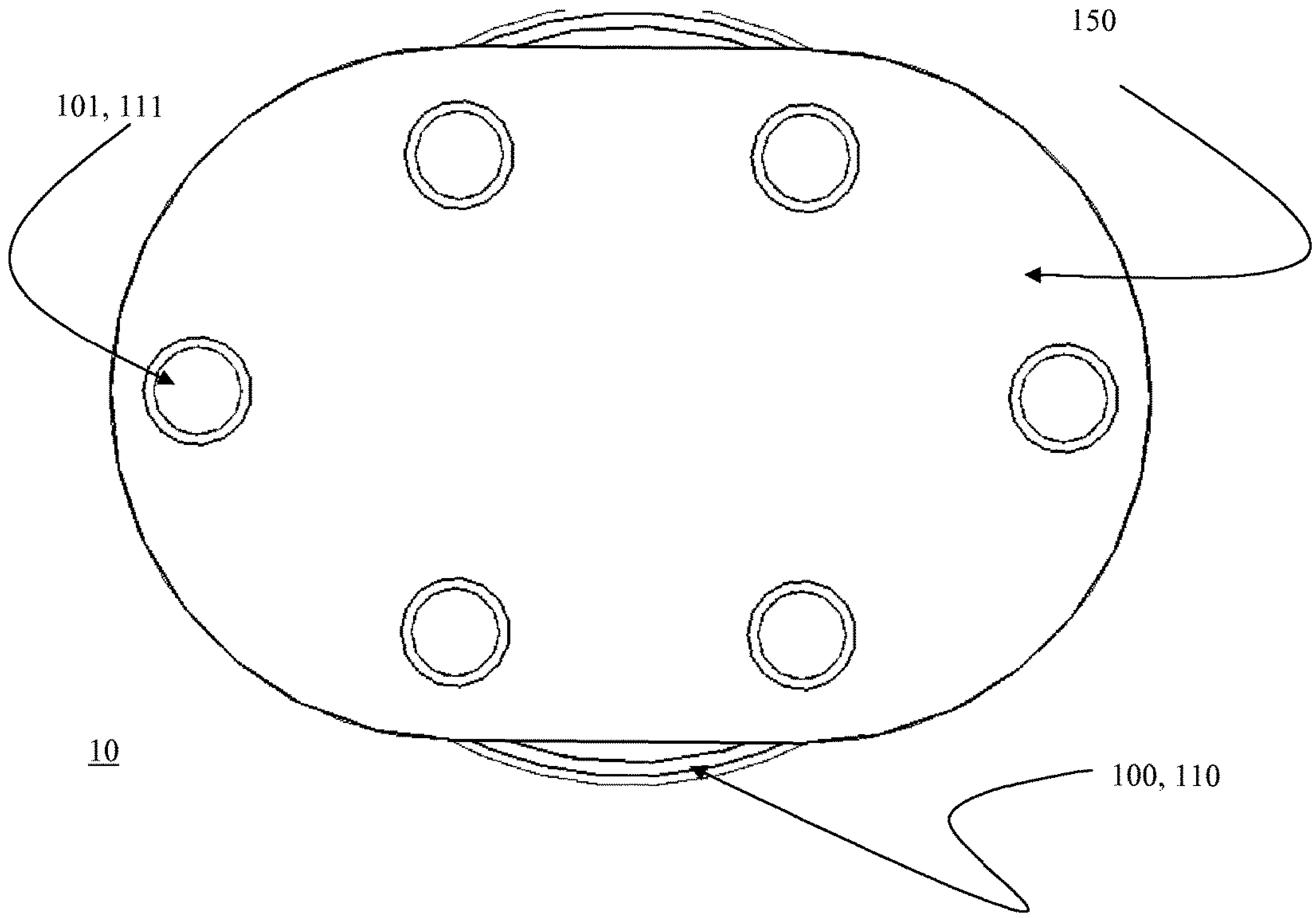
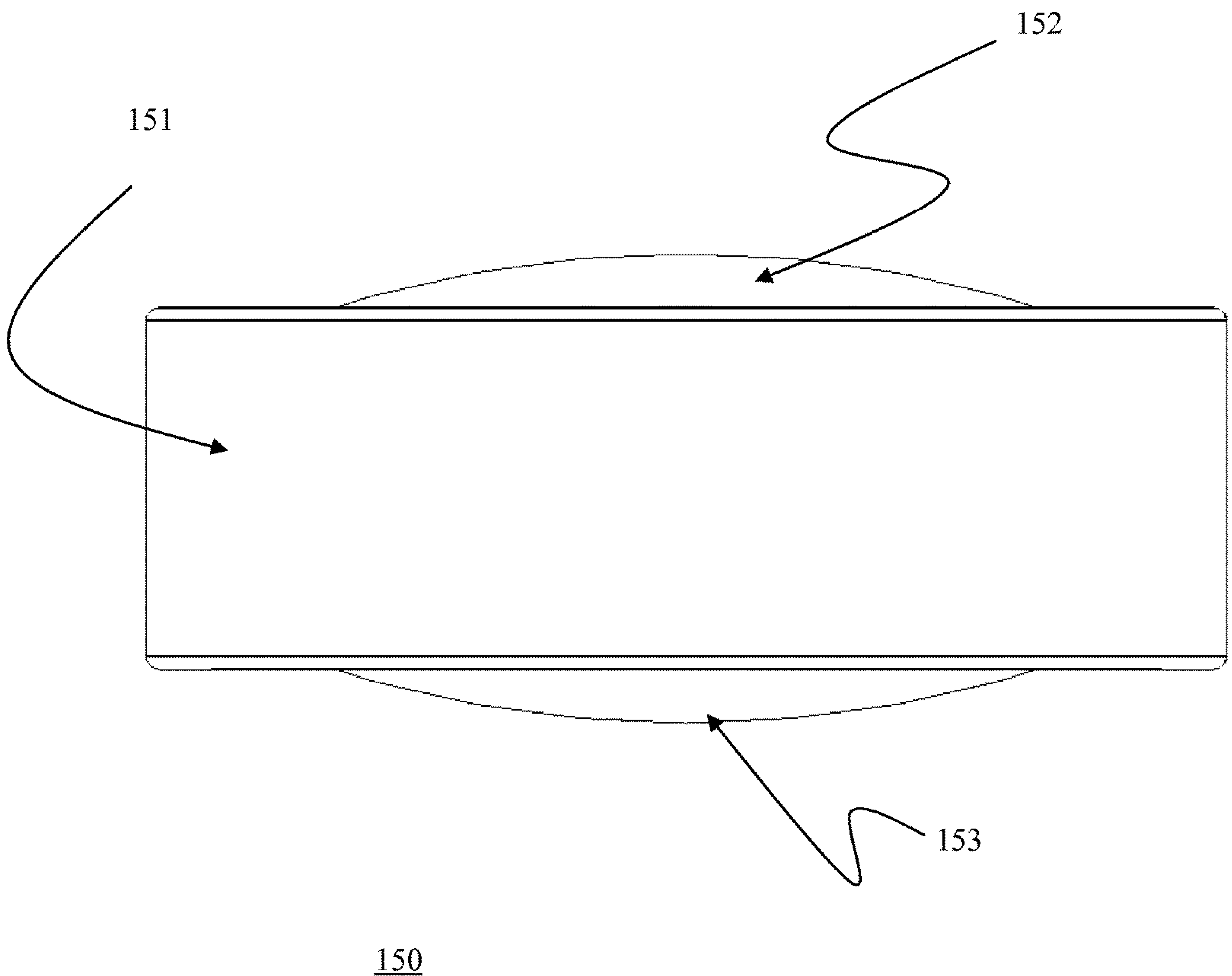



Figure 1D

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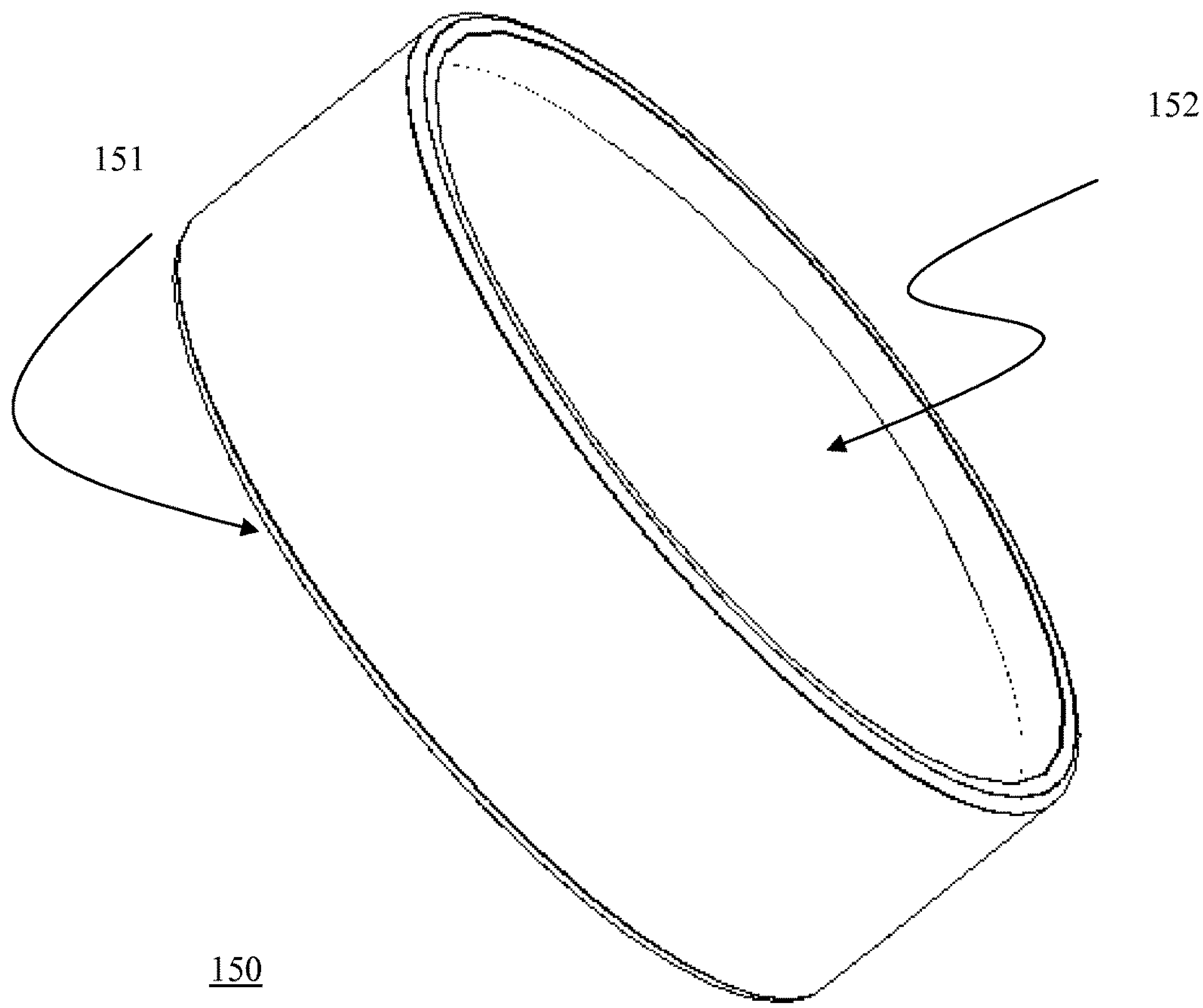


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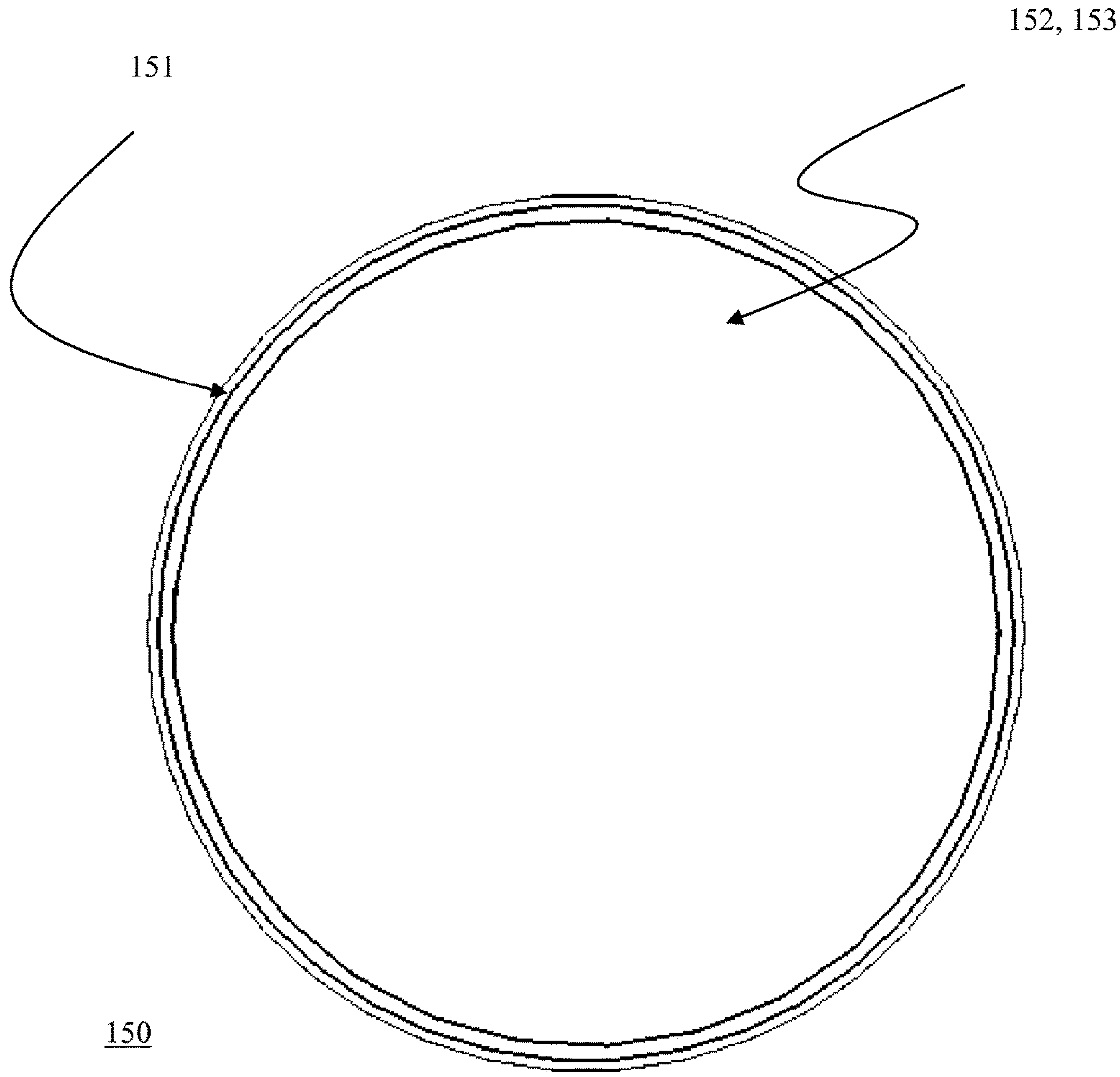


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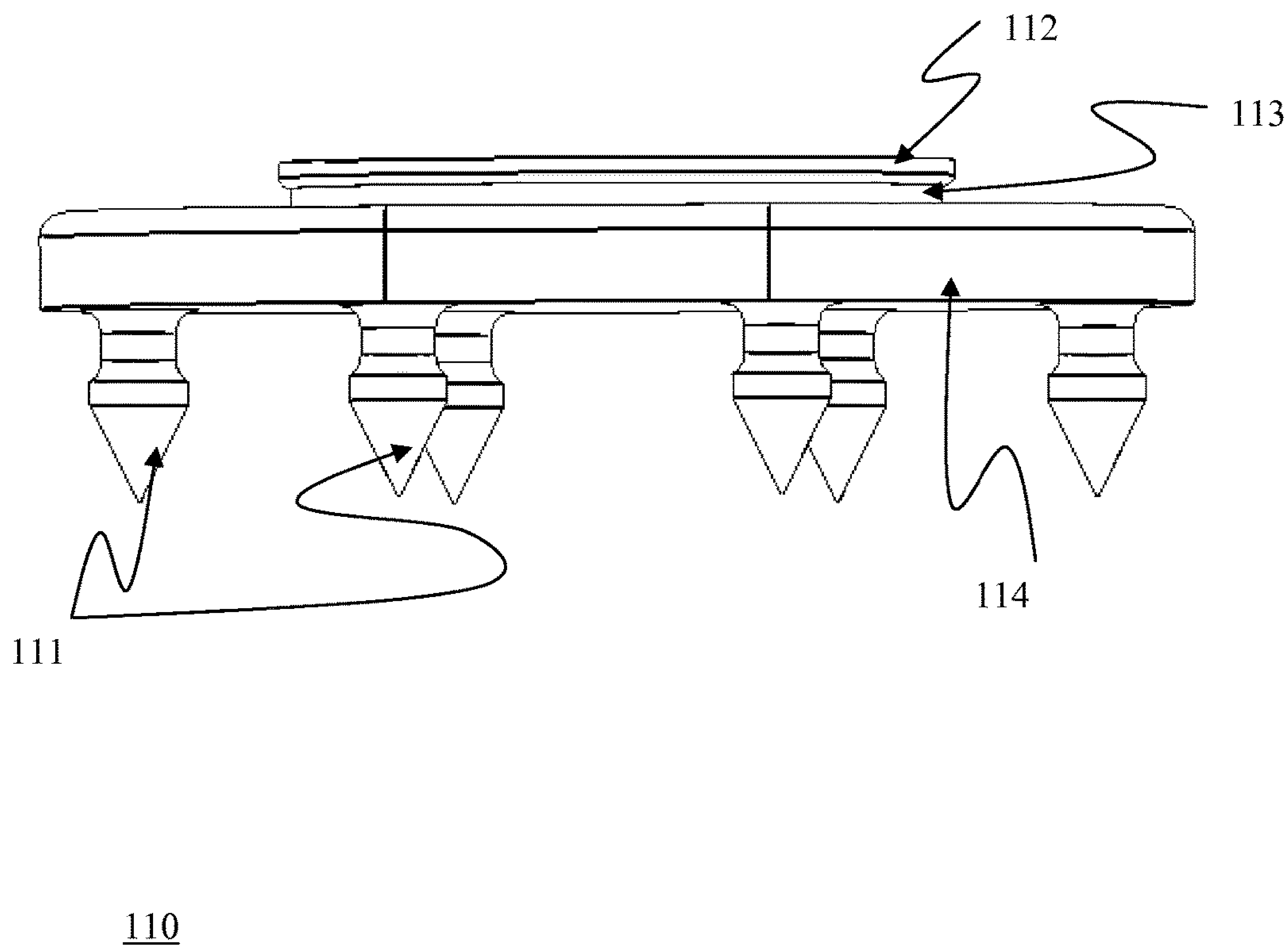


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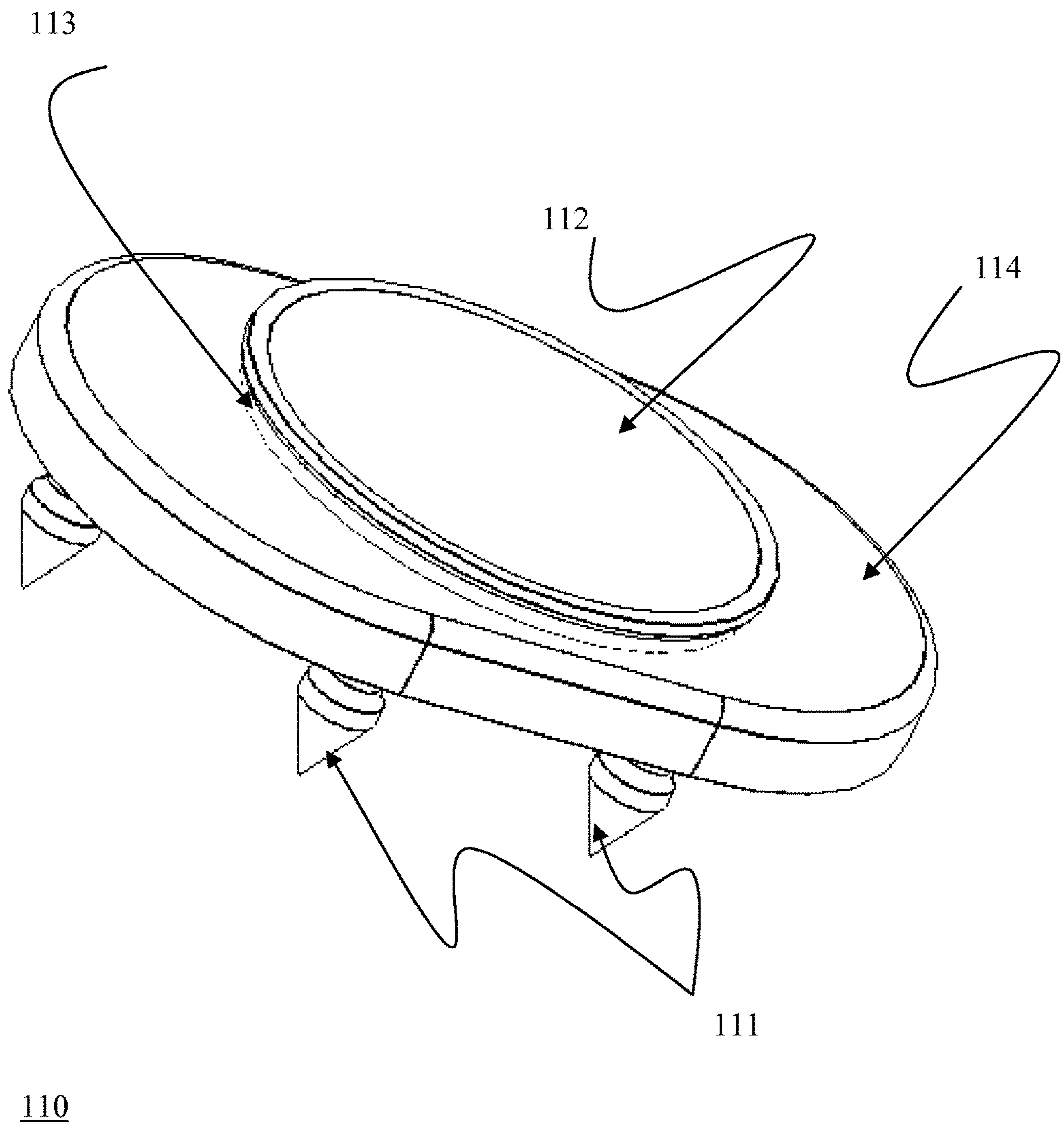


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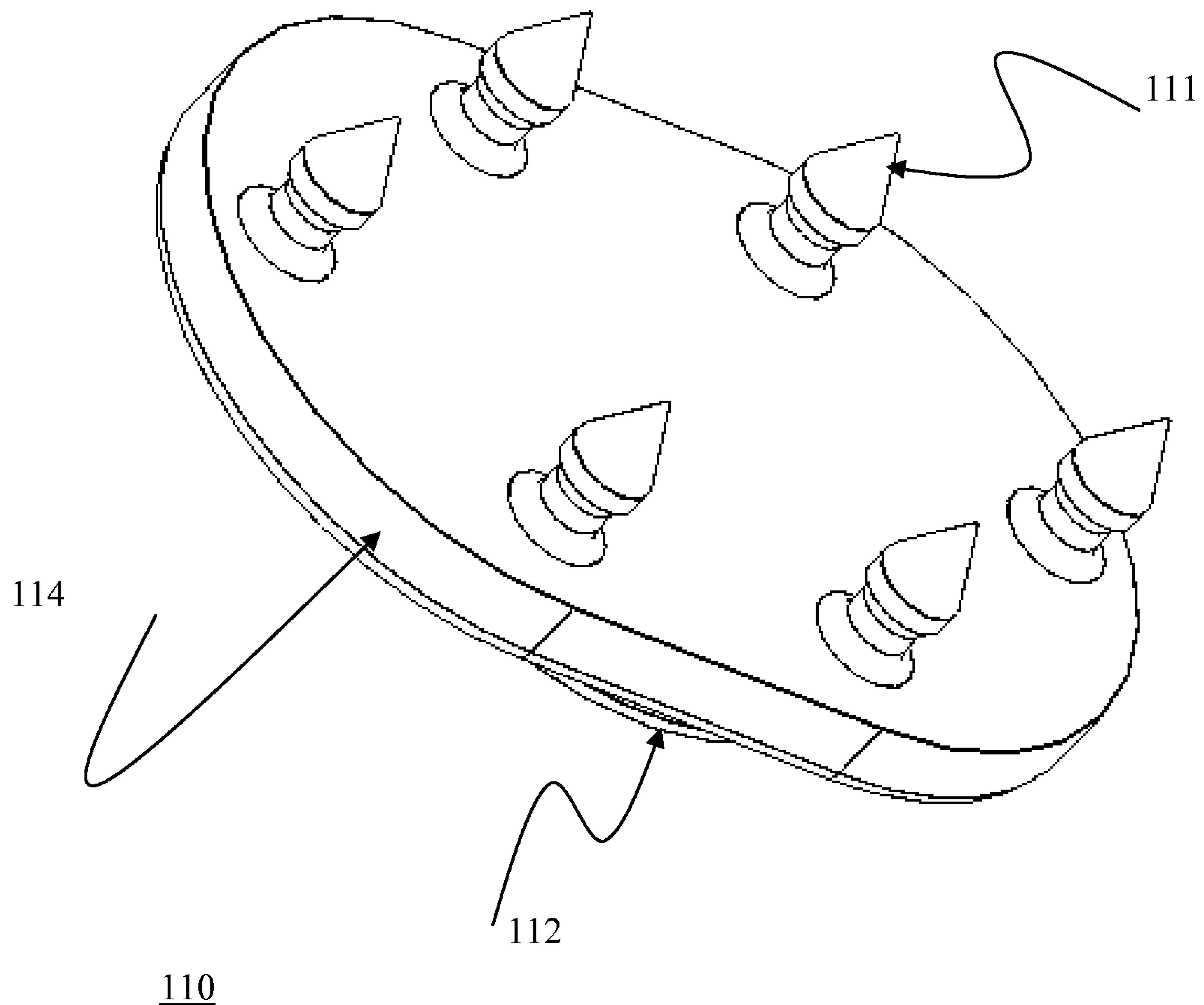


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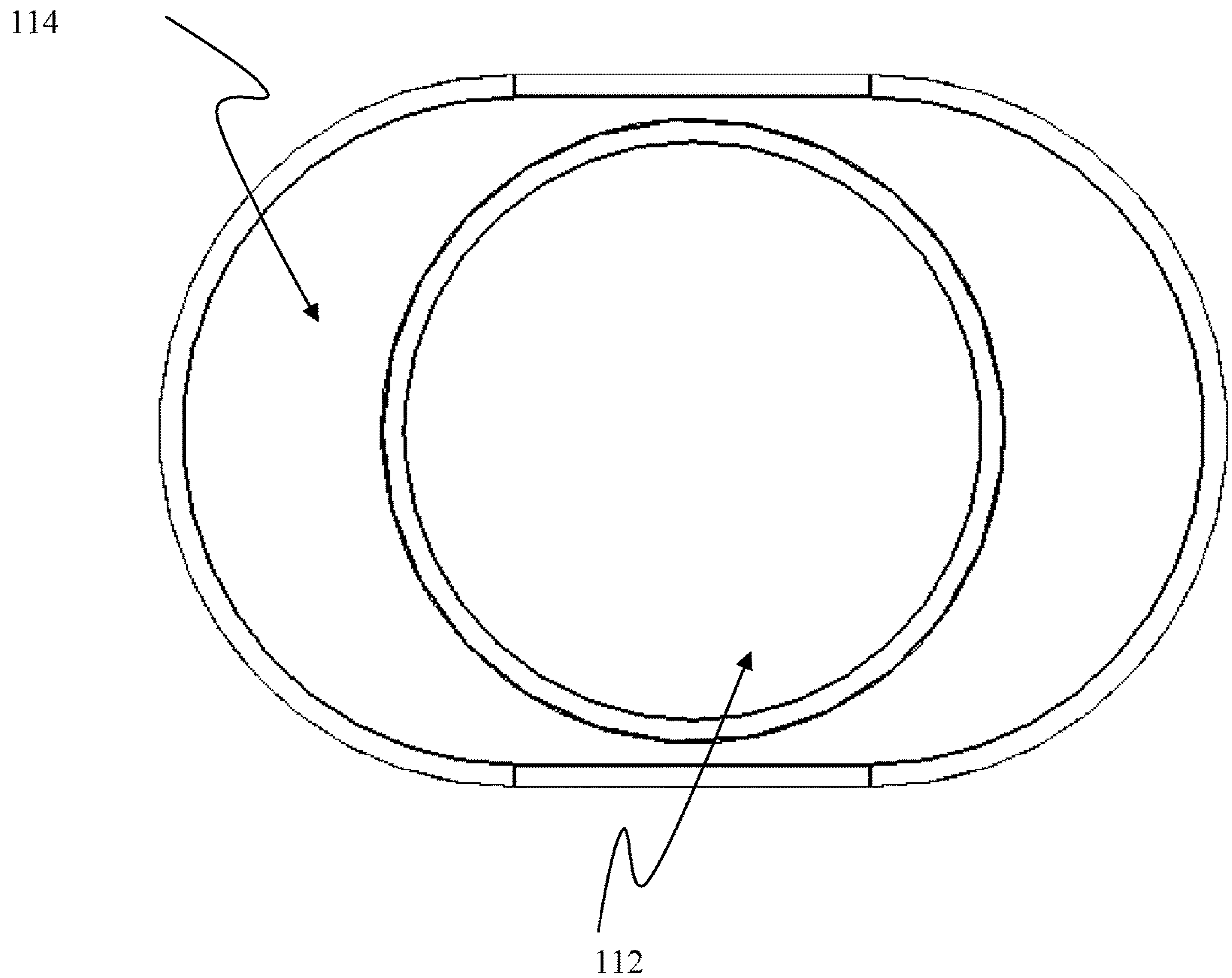


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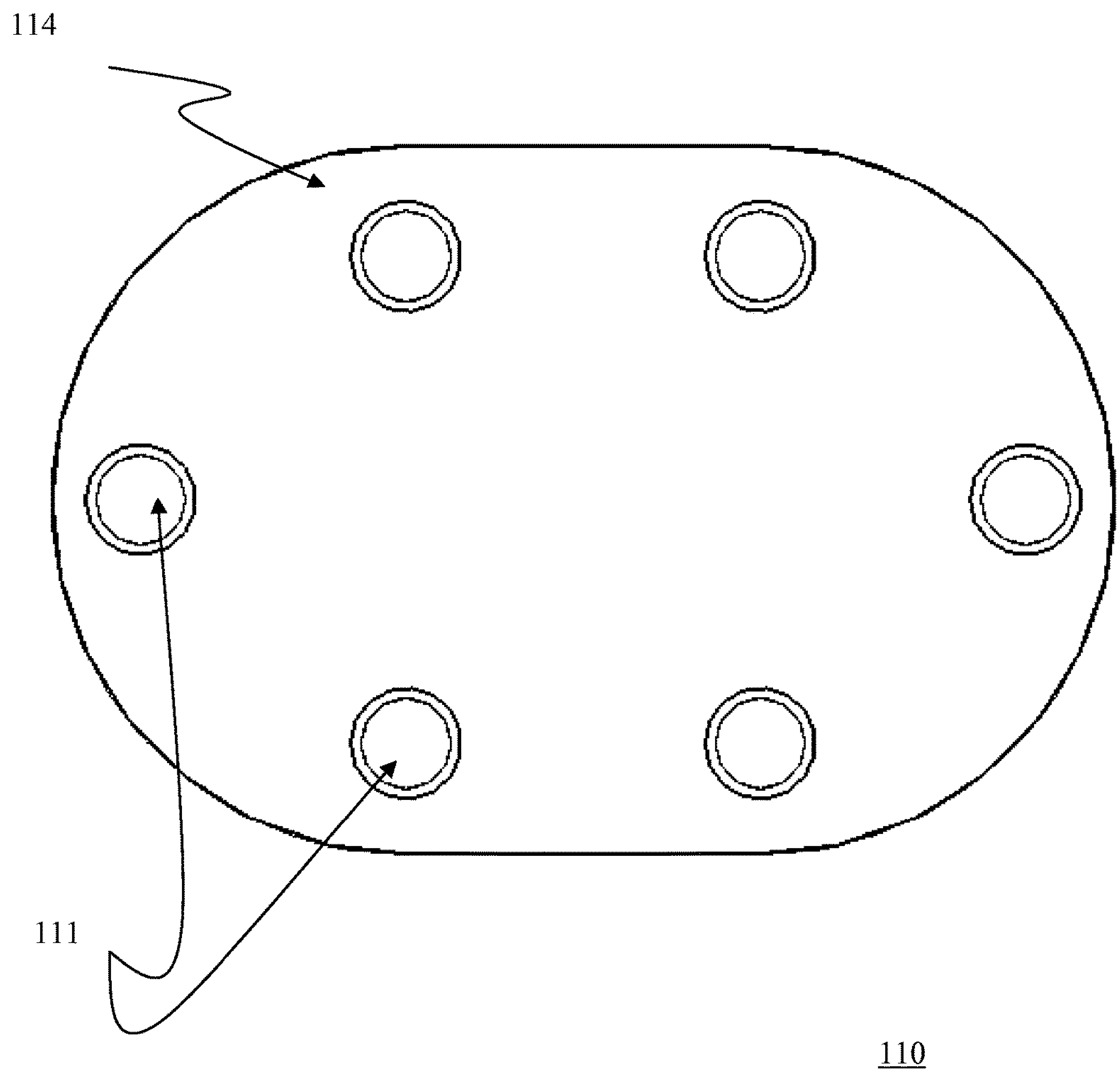


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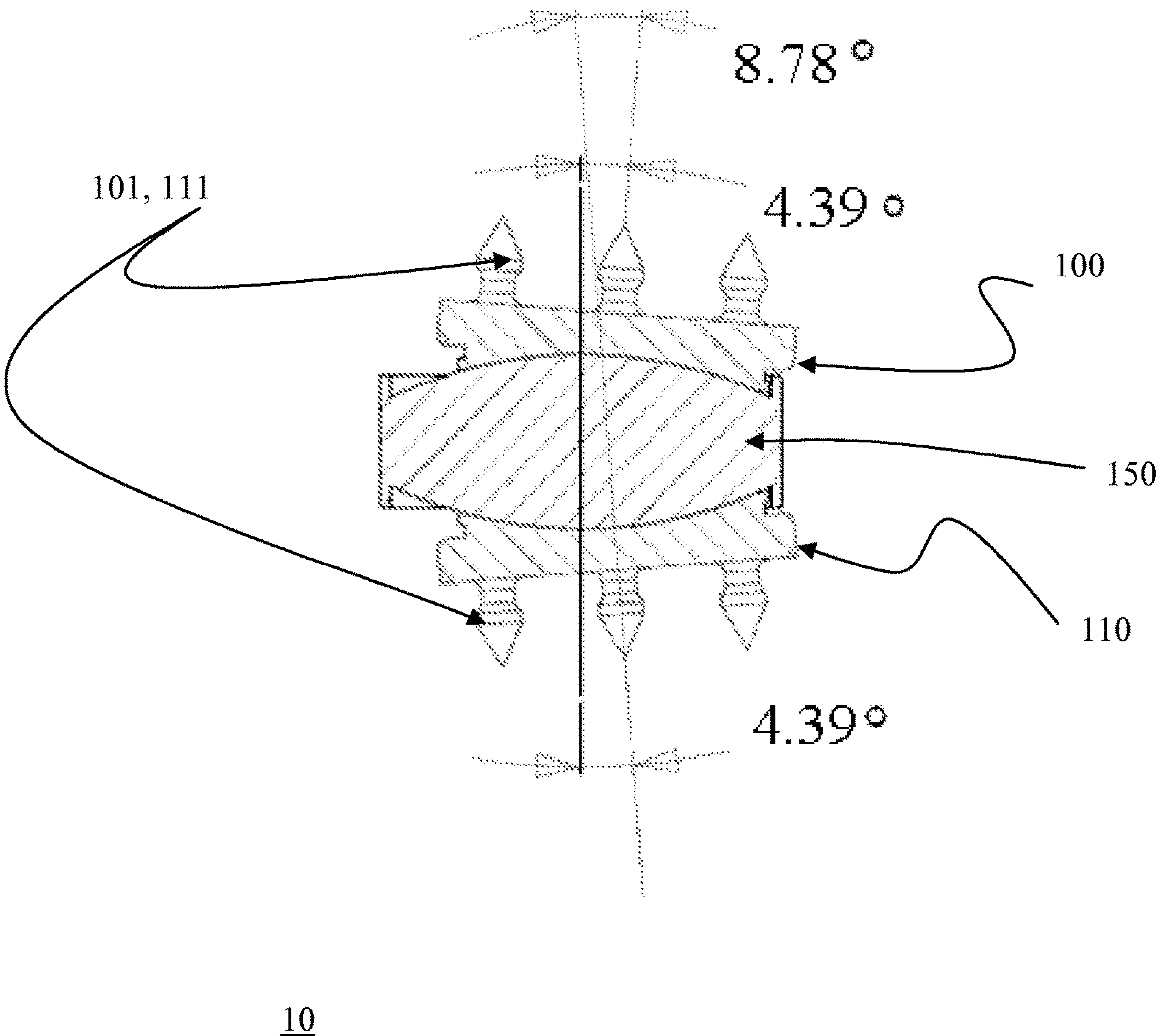


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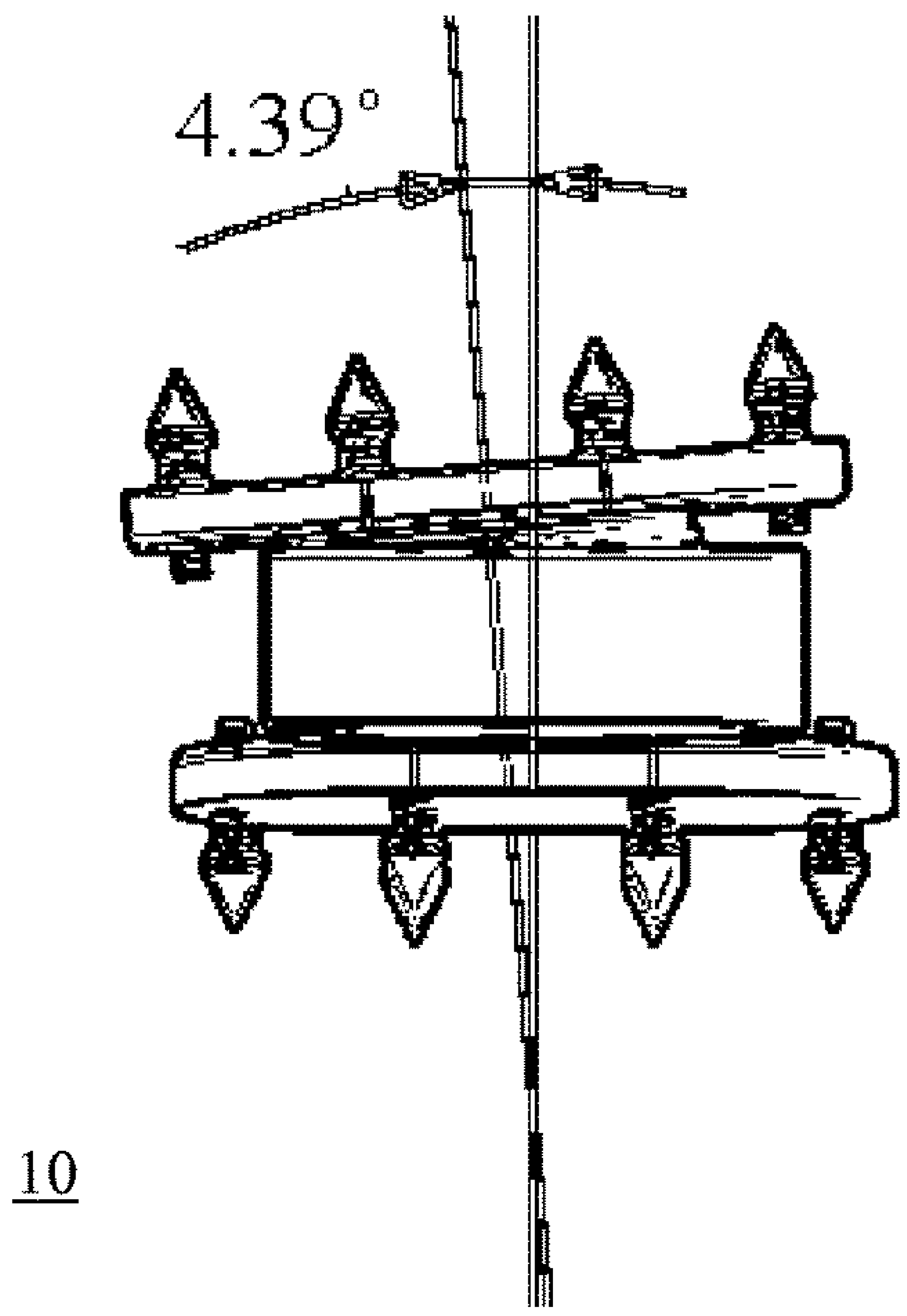


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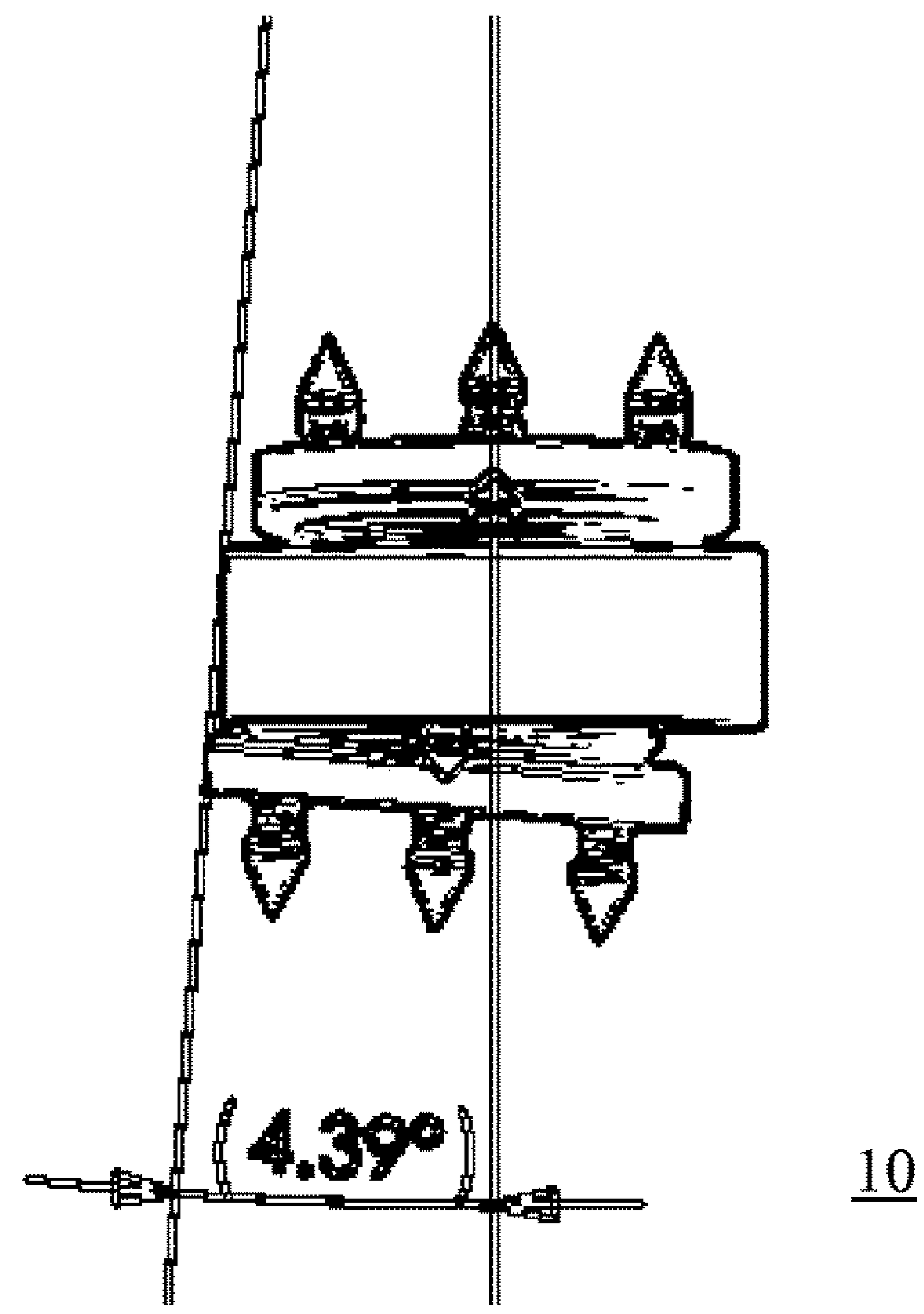


Figure 4Bii

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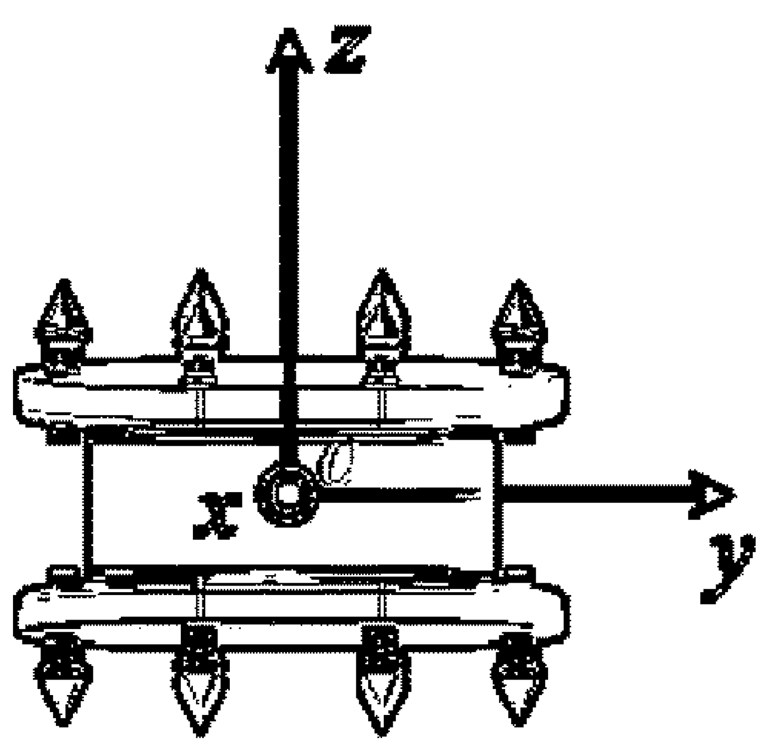


Figure 4Ci: Front View

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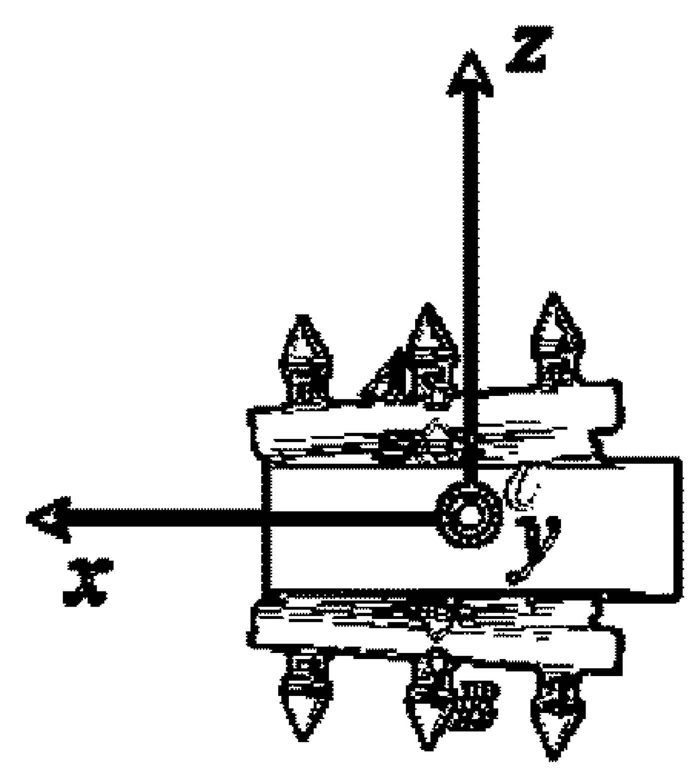


Figure 4Cii: Side View

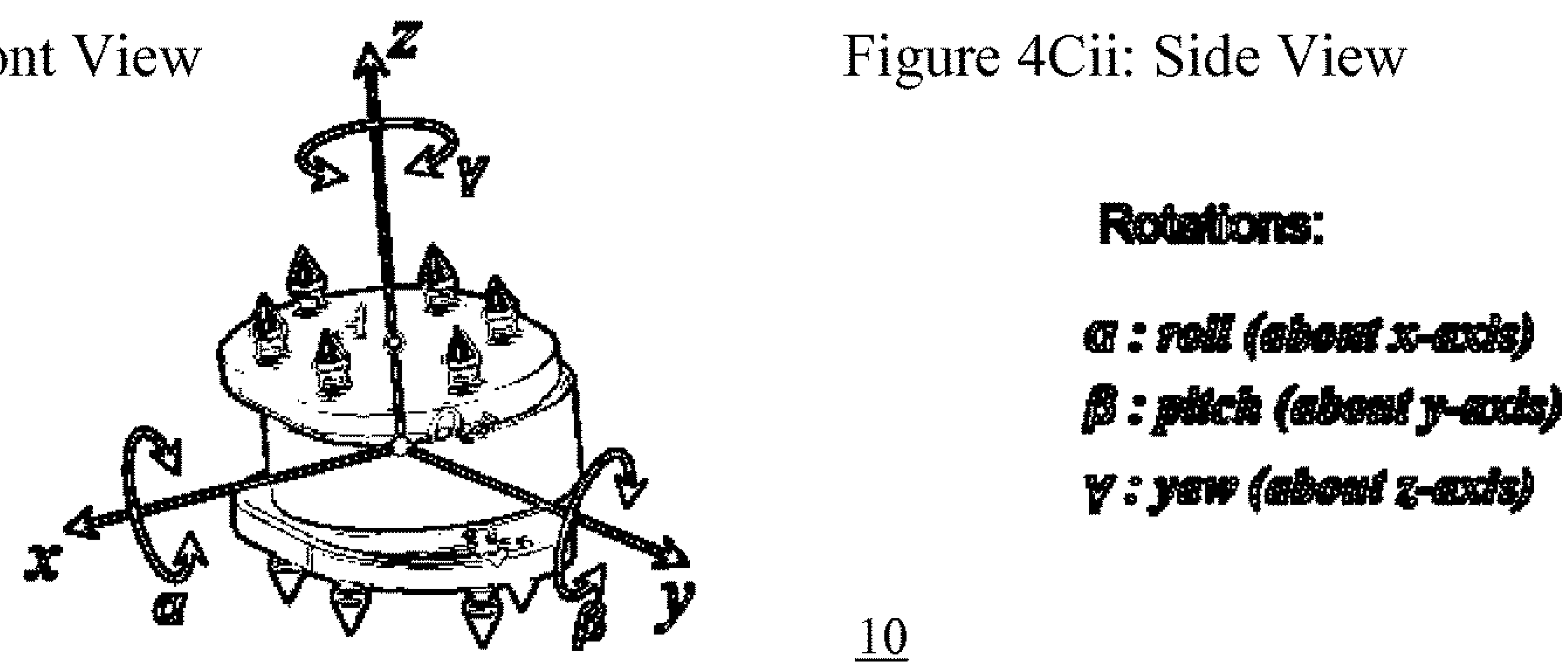


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Figure 4Ciii: Perspective View from Front-Side

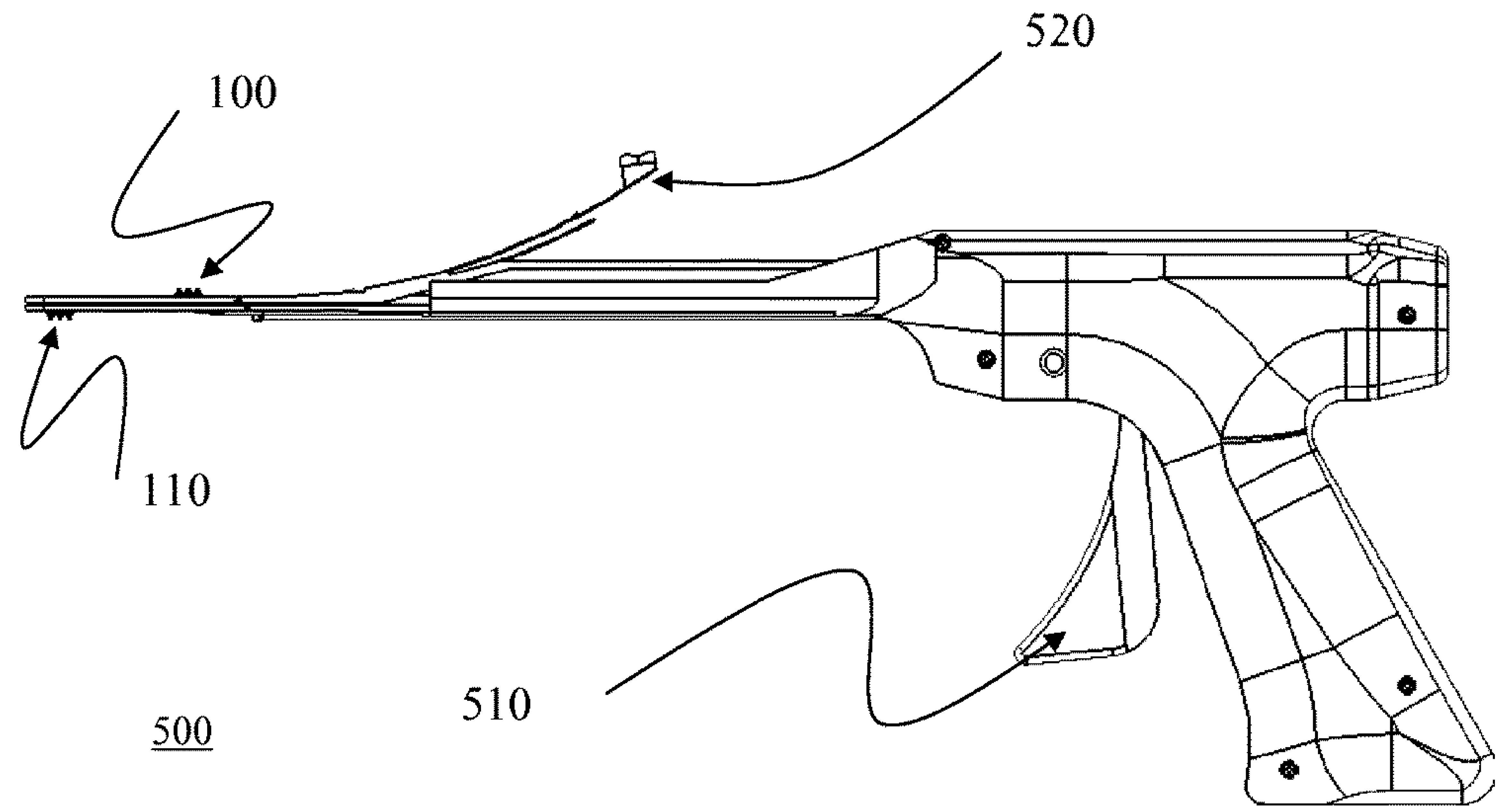



Fig. 5A

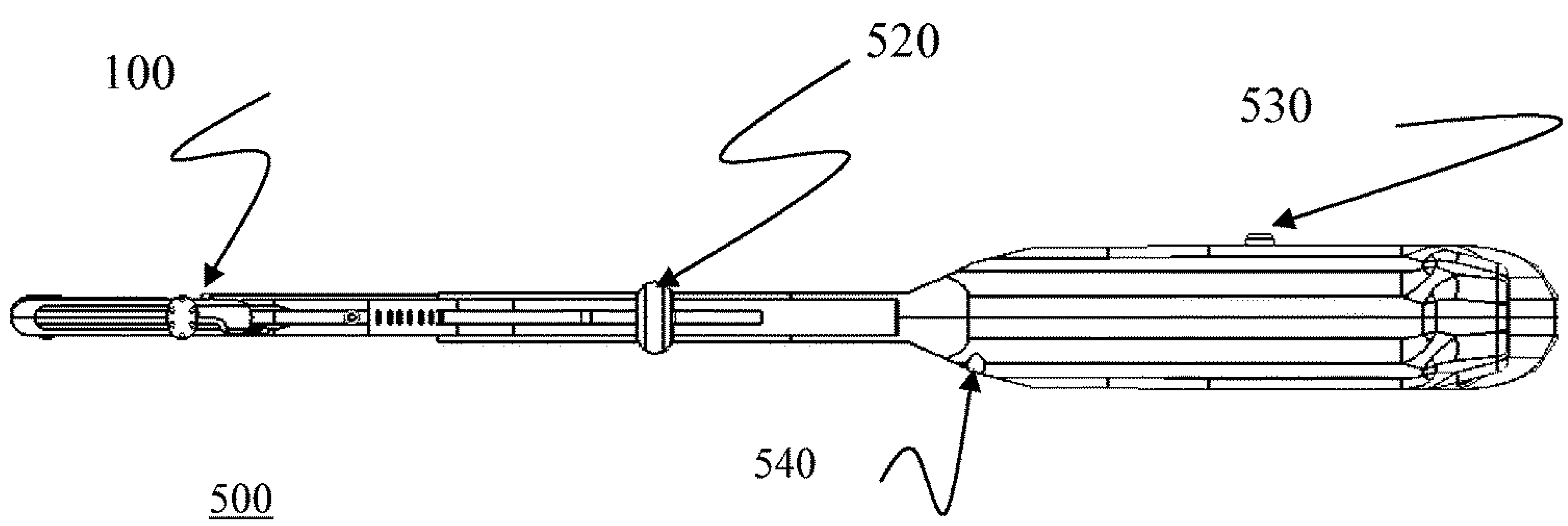



Fig. 5B

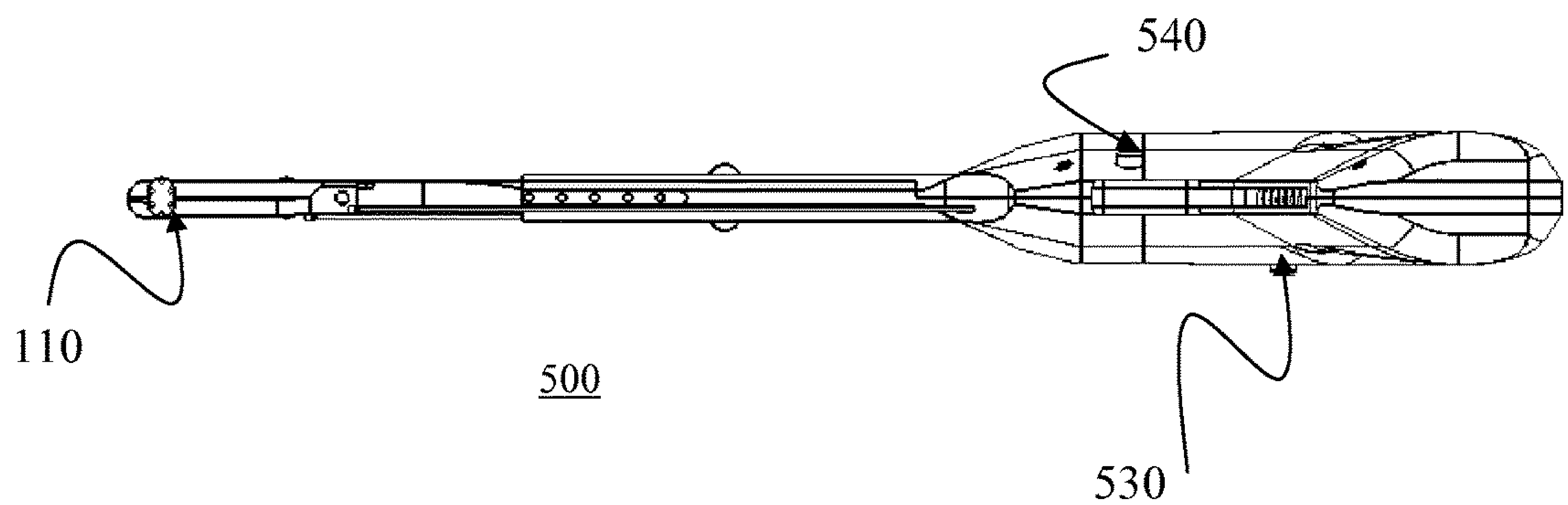
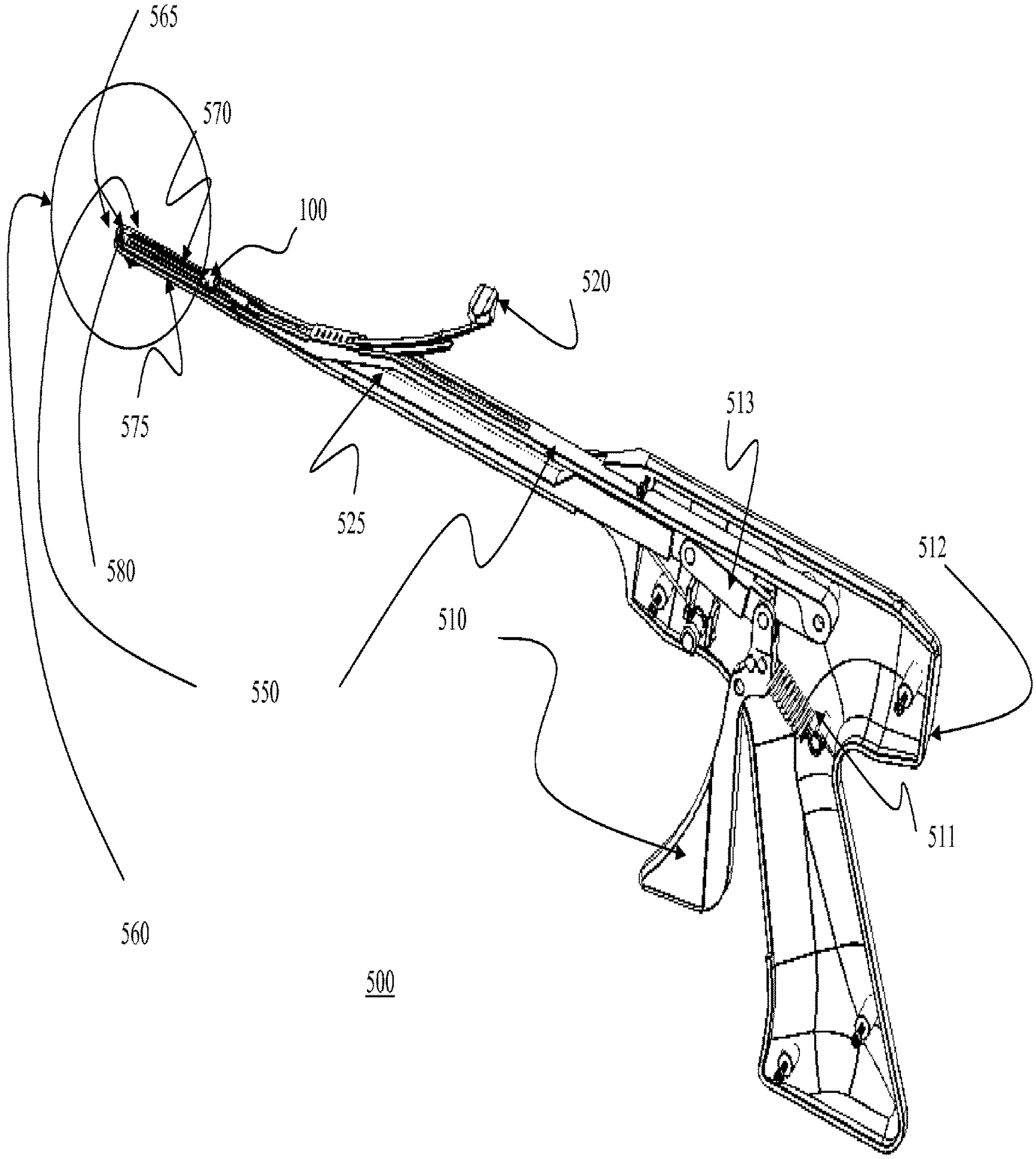



Fig. 5C

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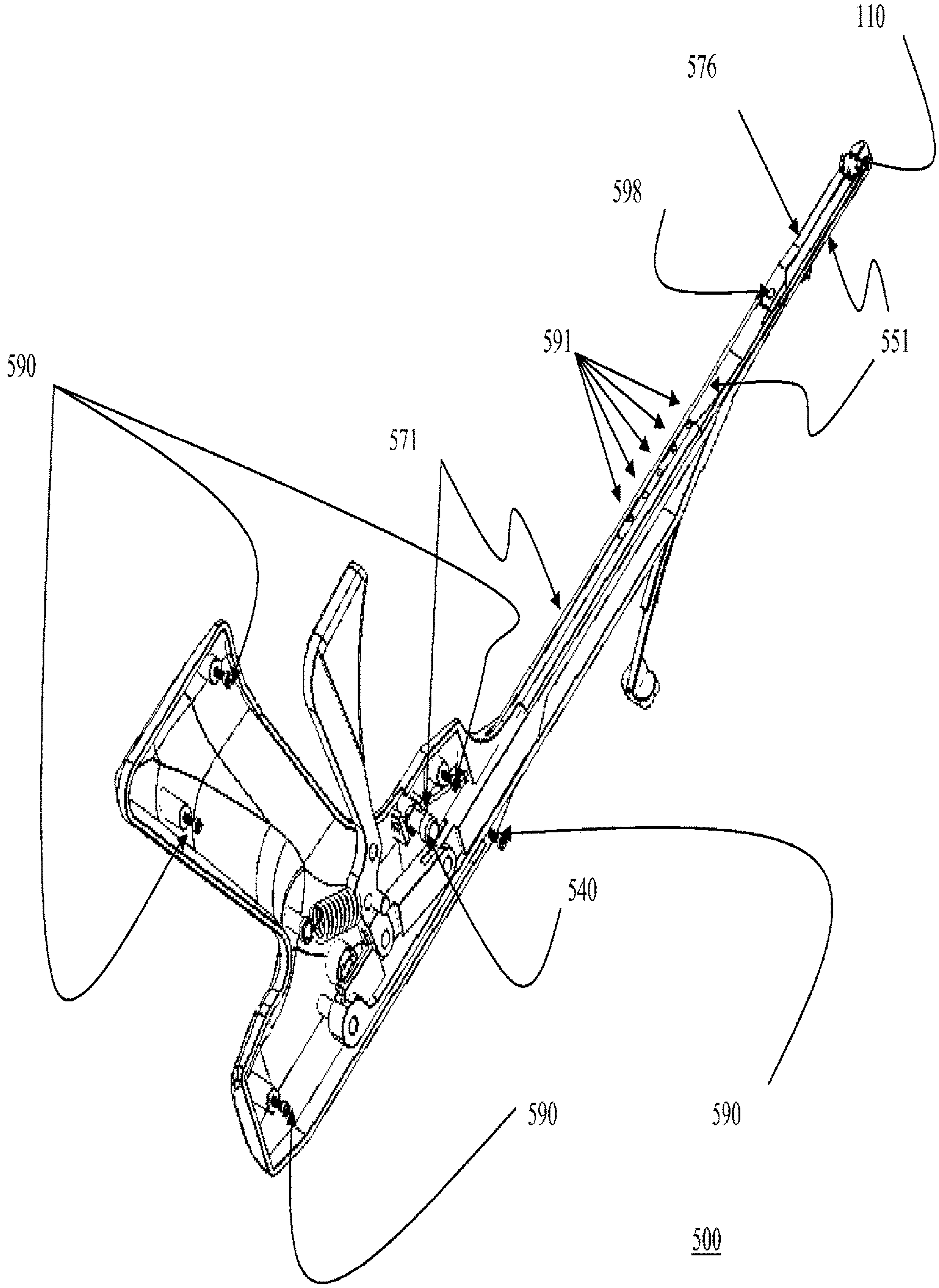


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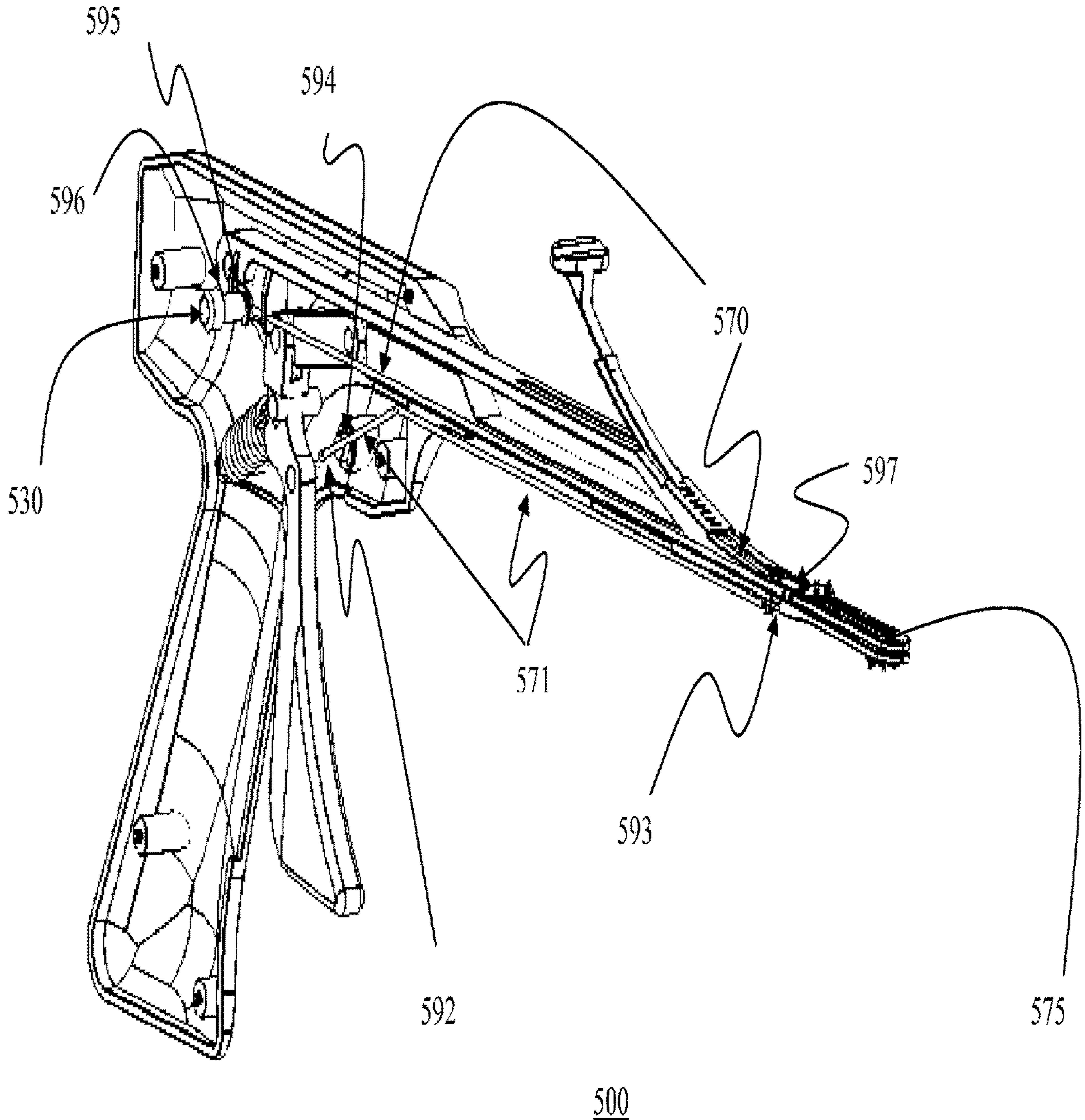


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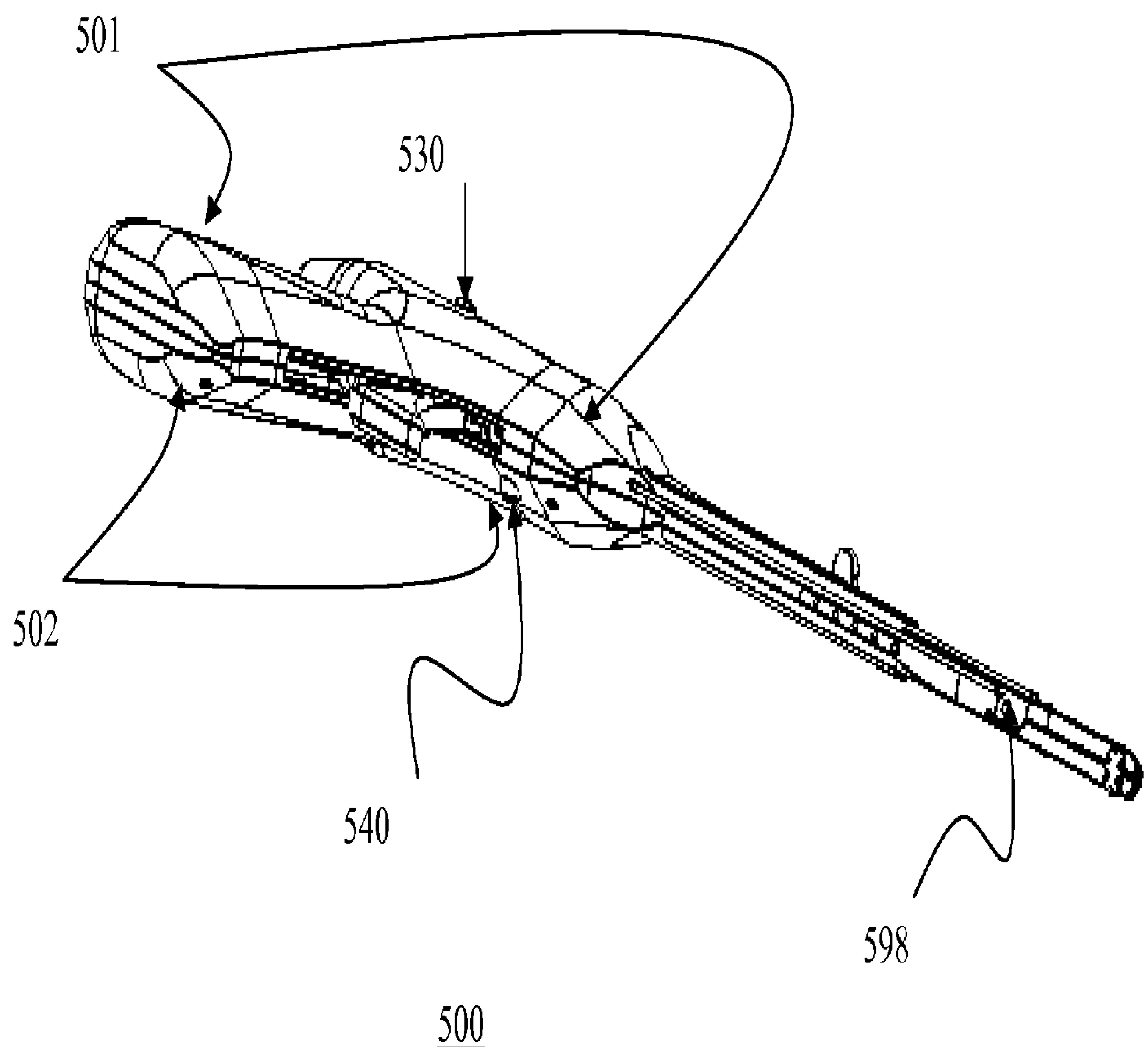


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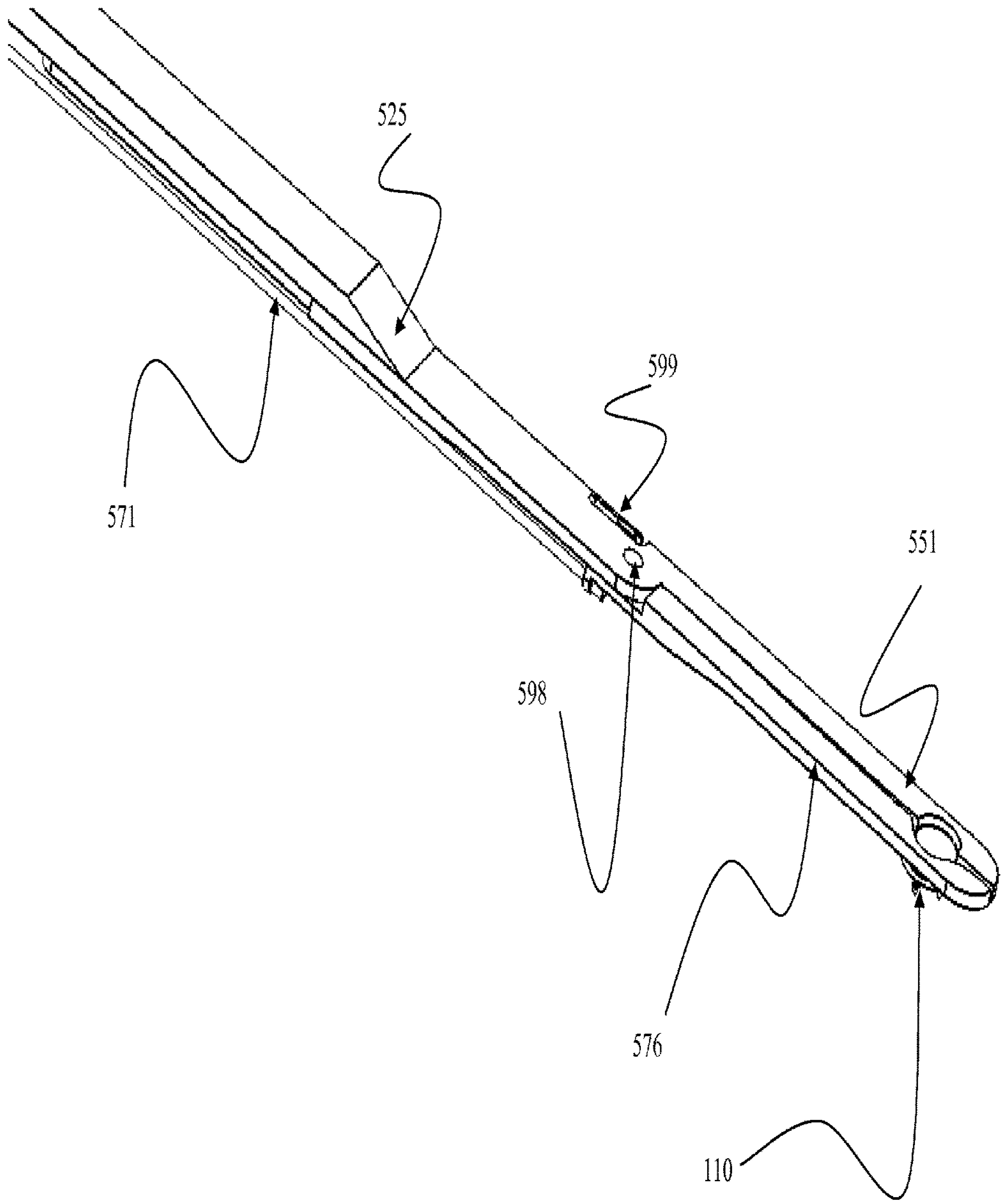


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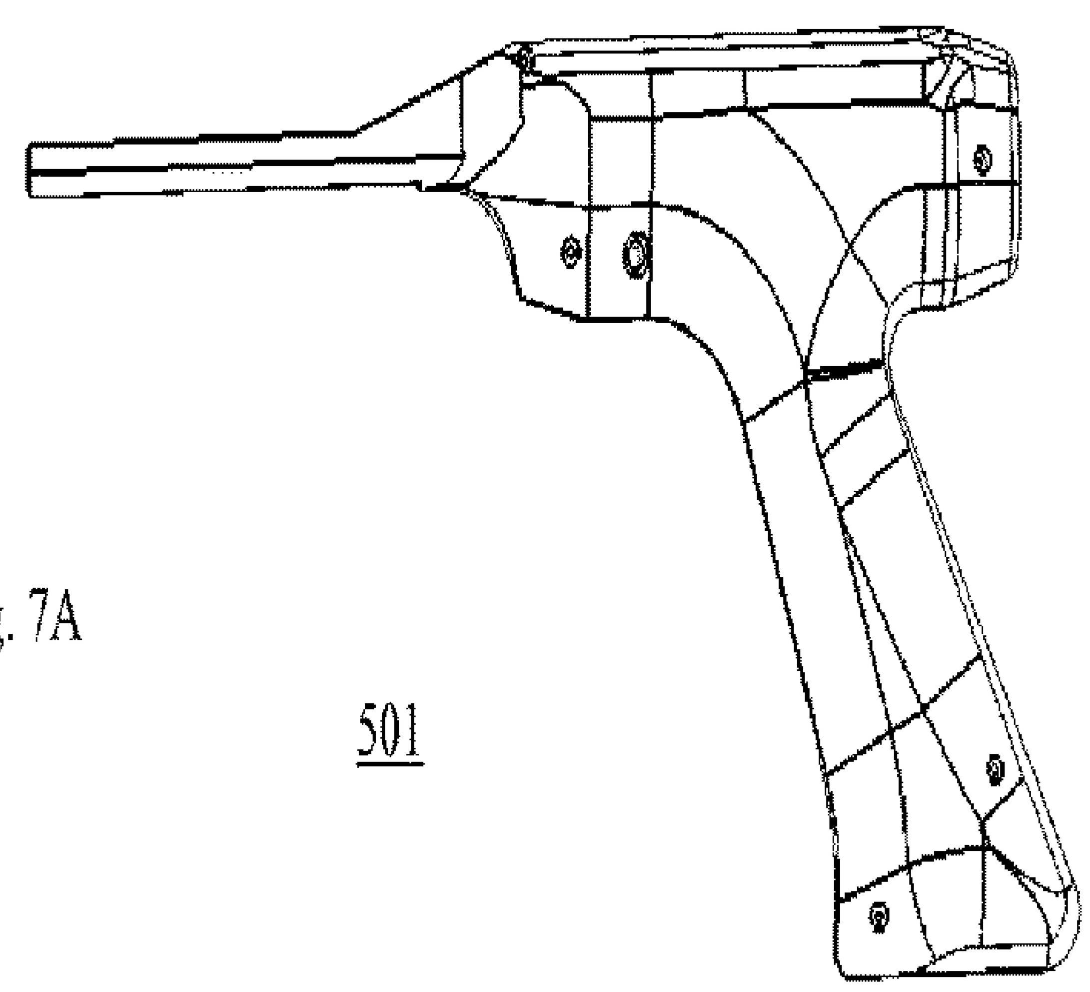


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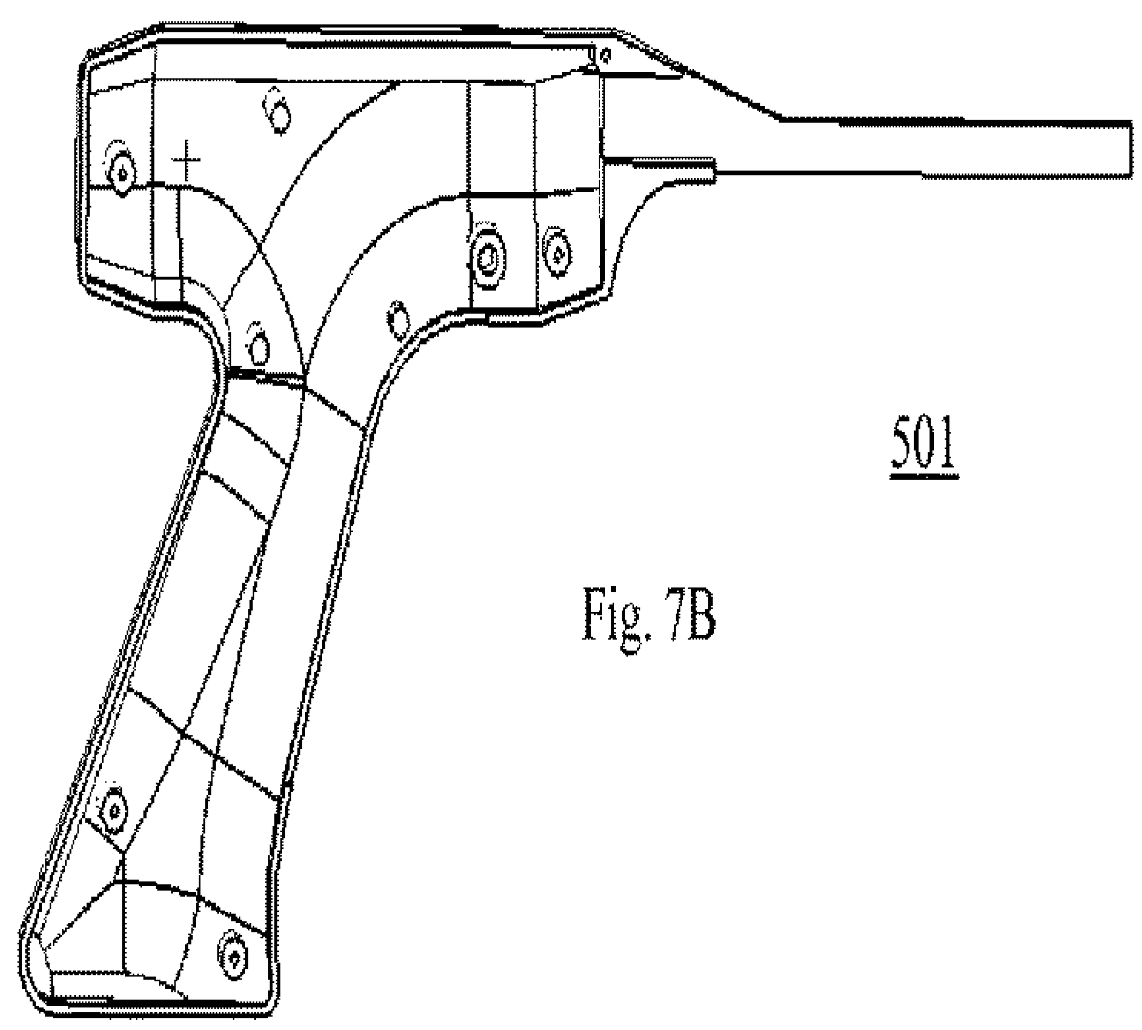


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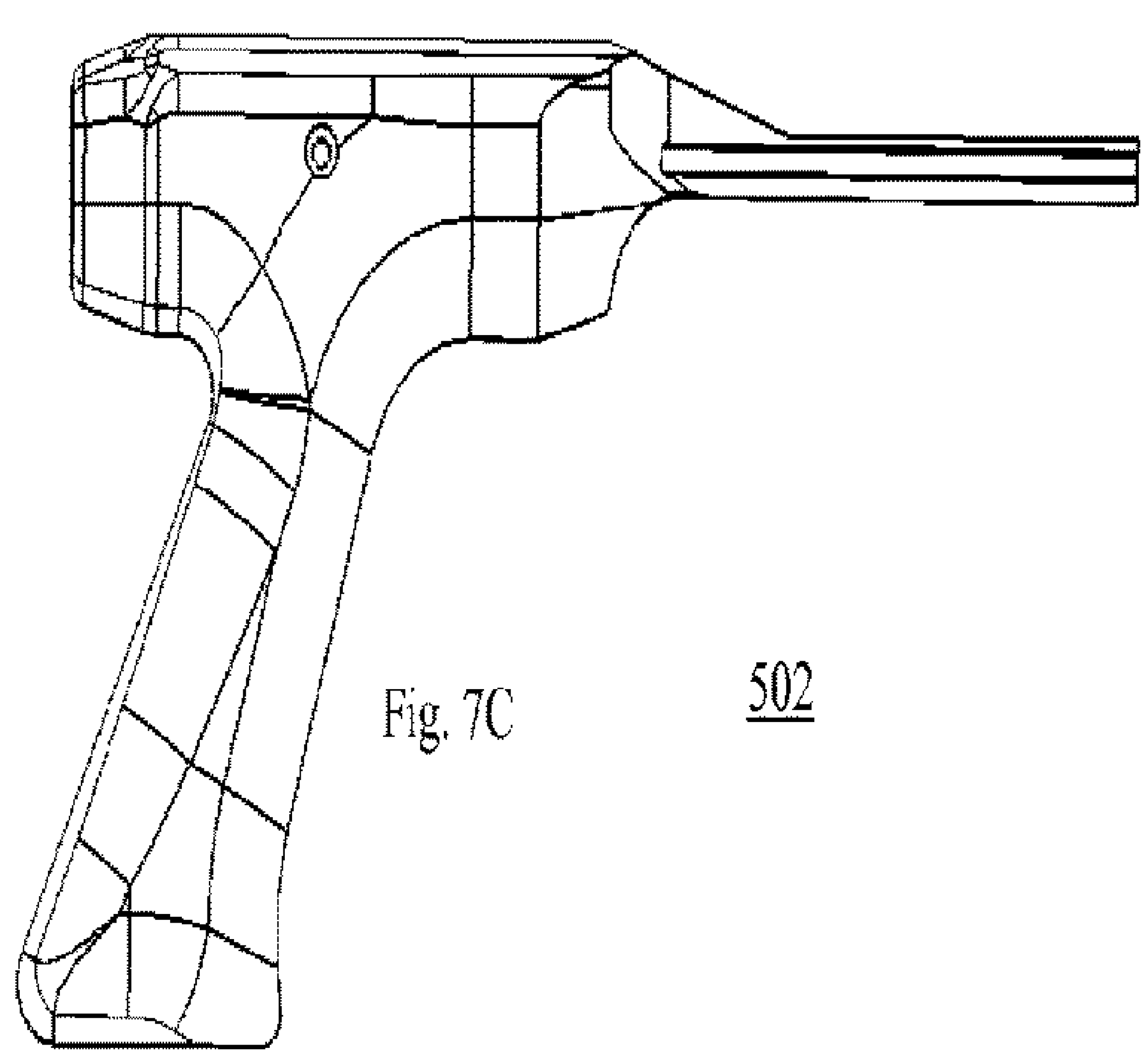
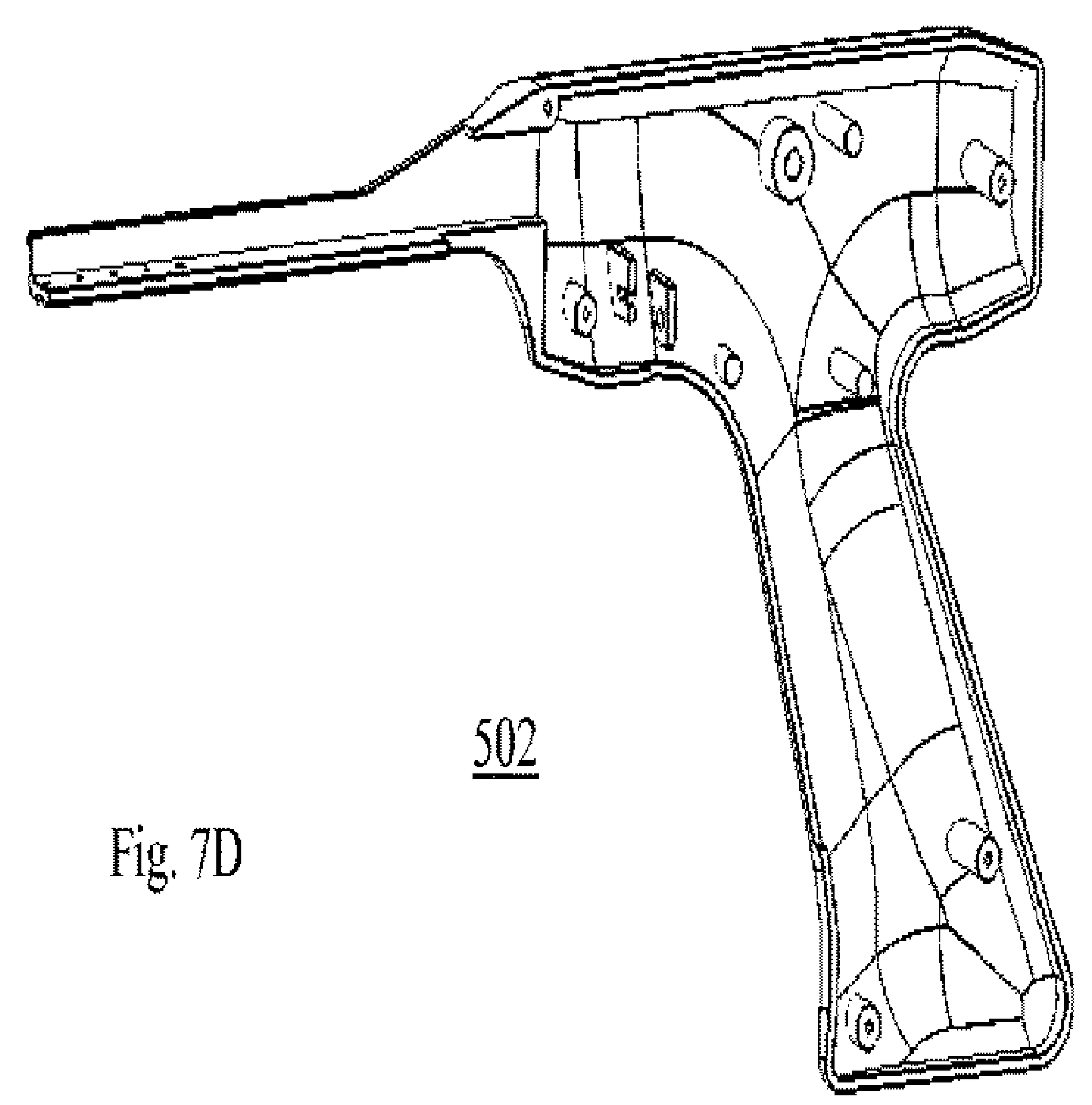



Fig. 7C

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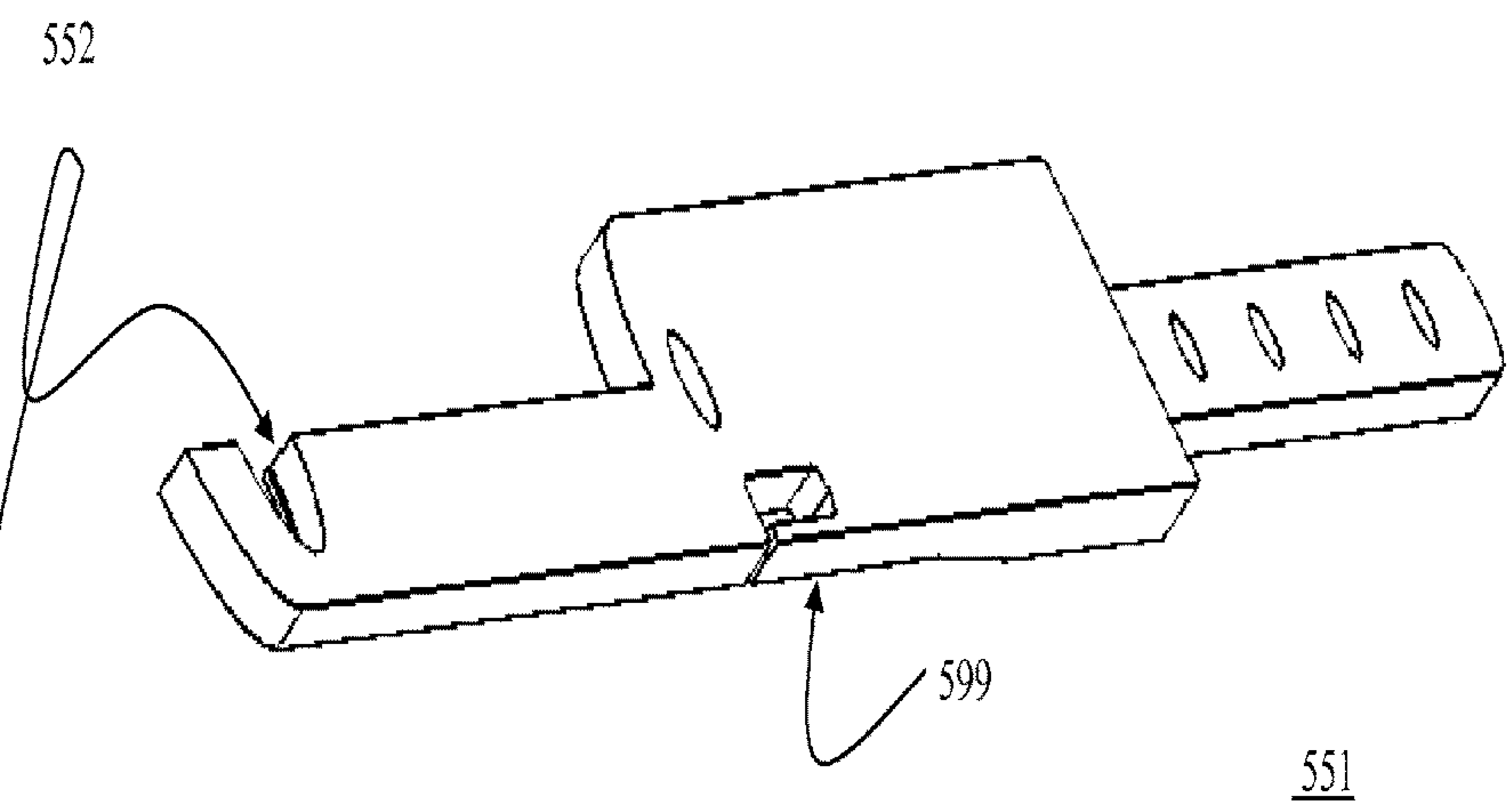


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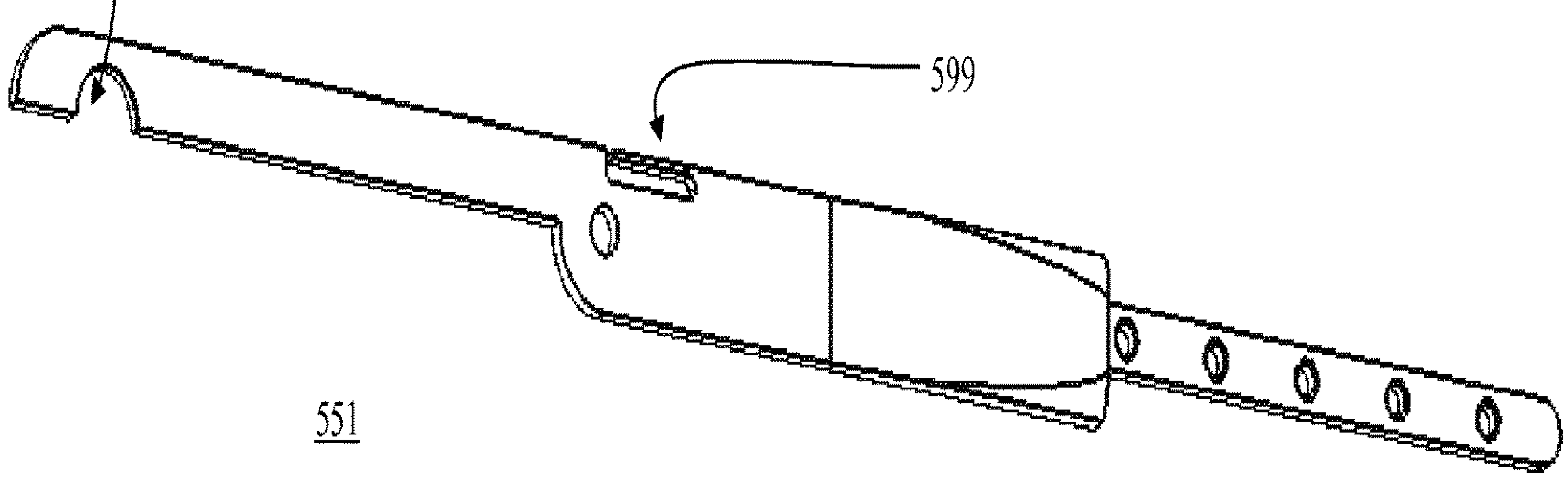


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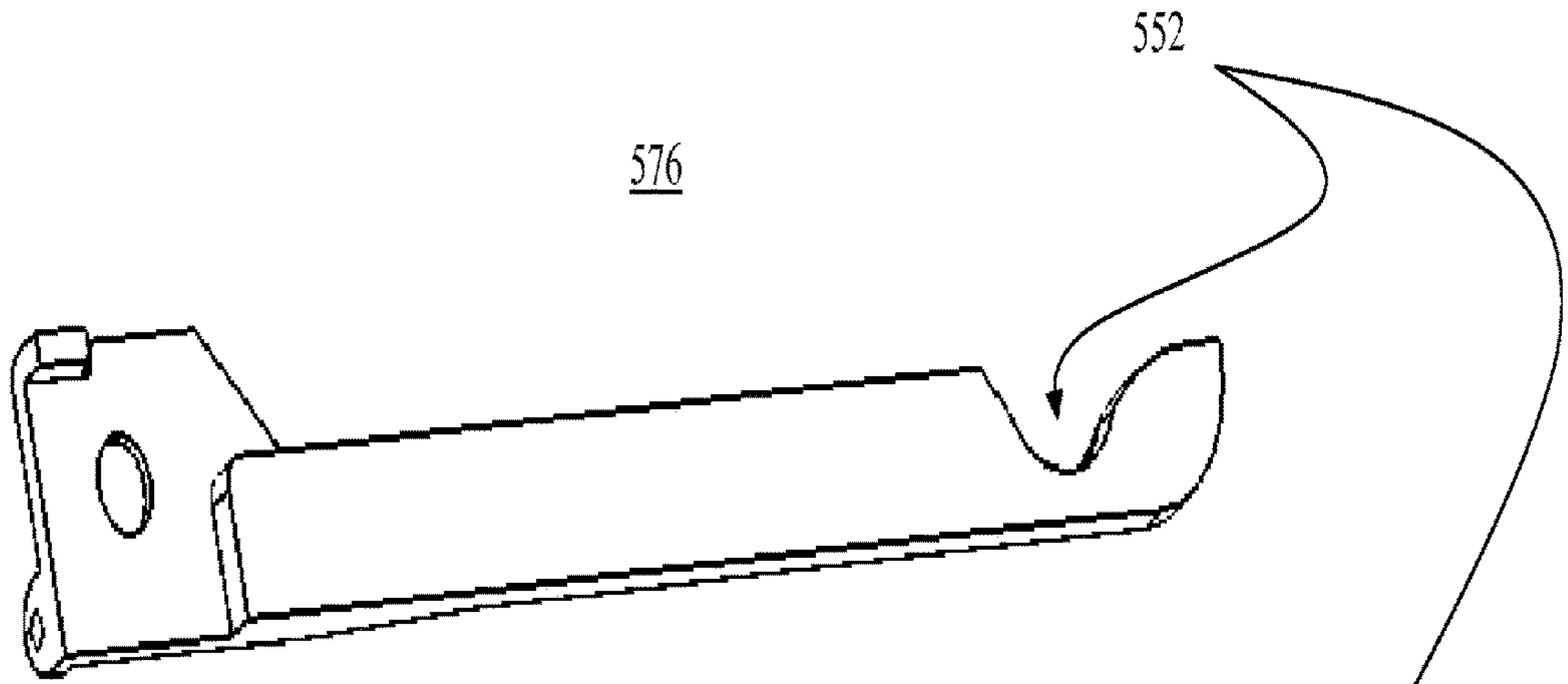


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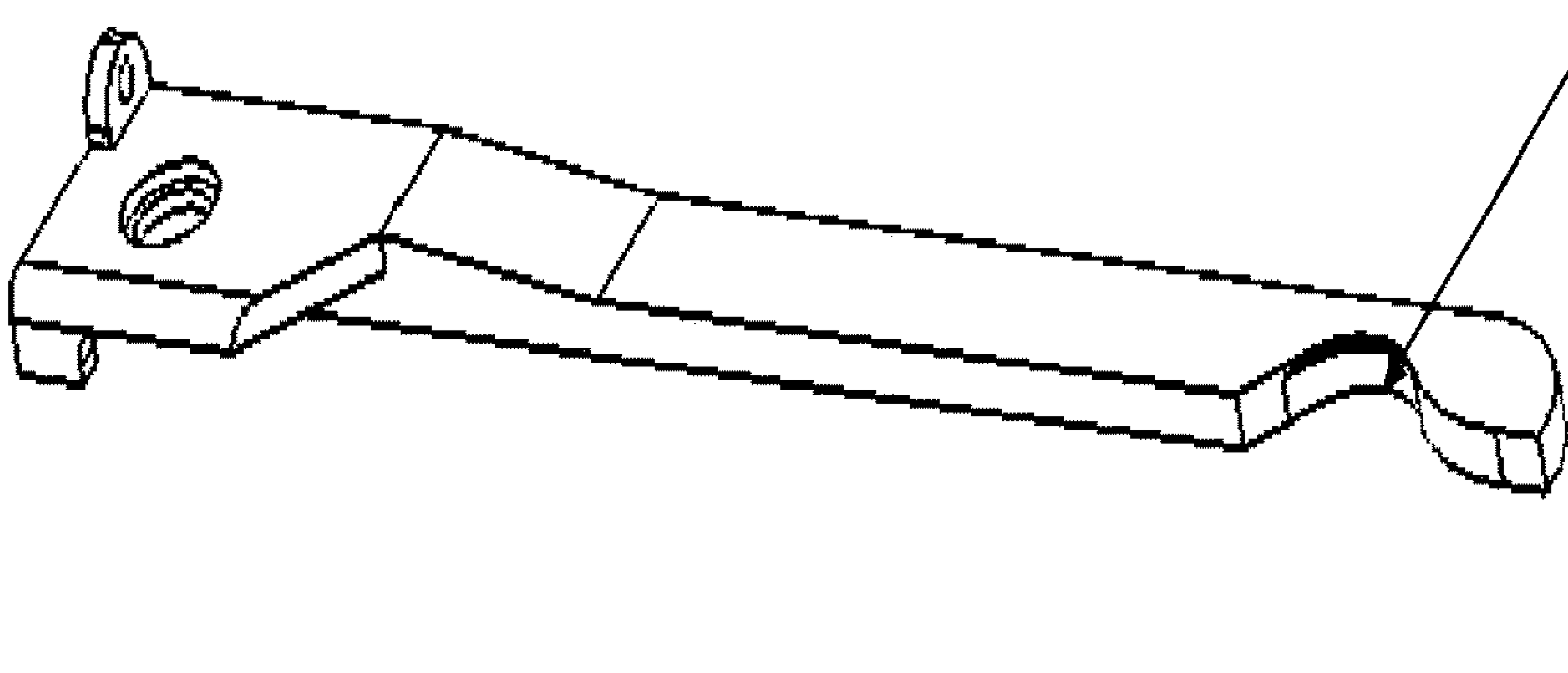


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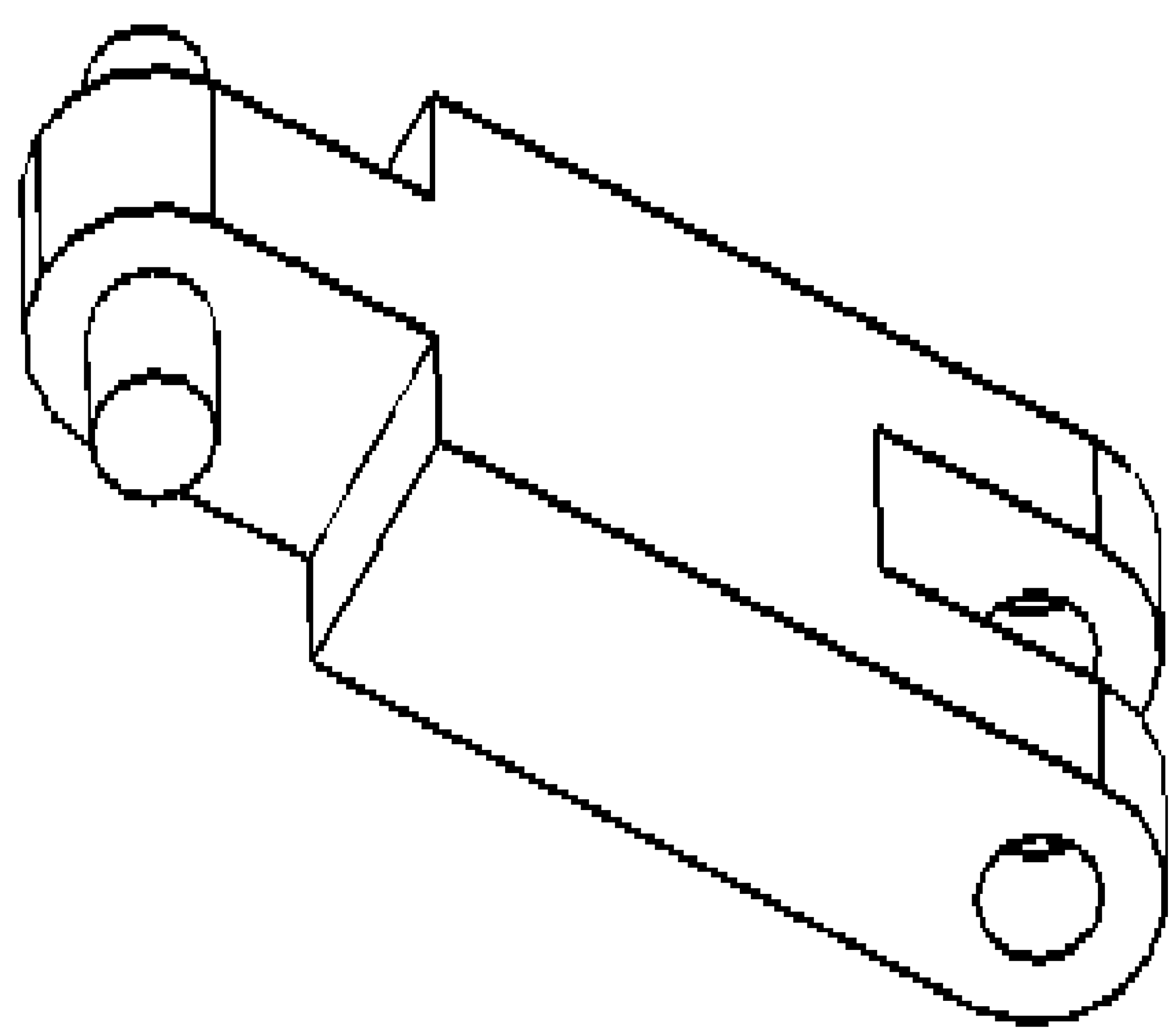

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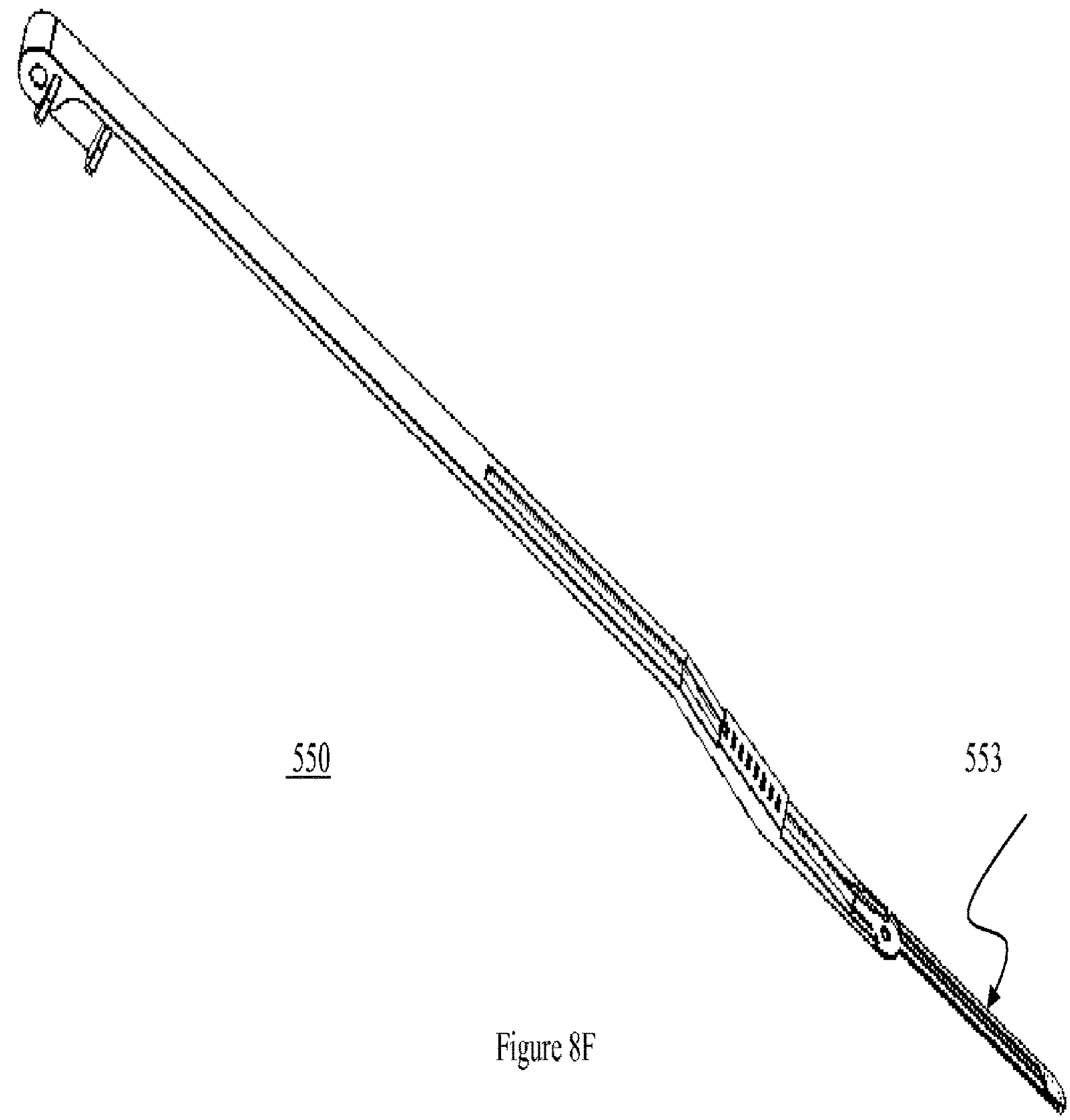


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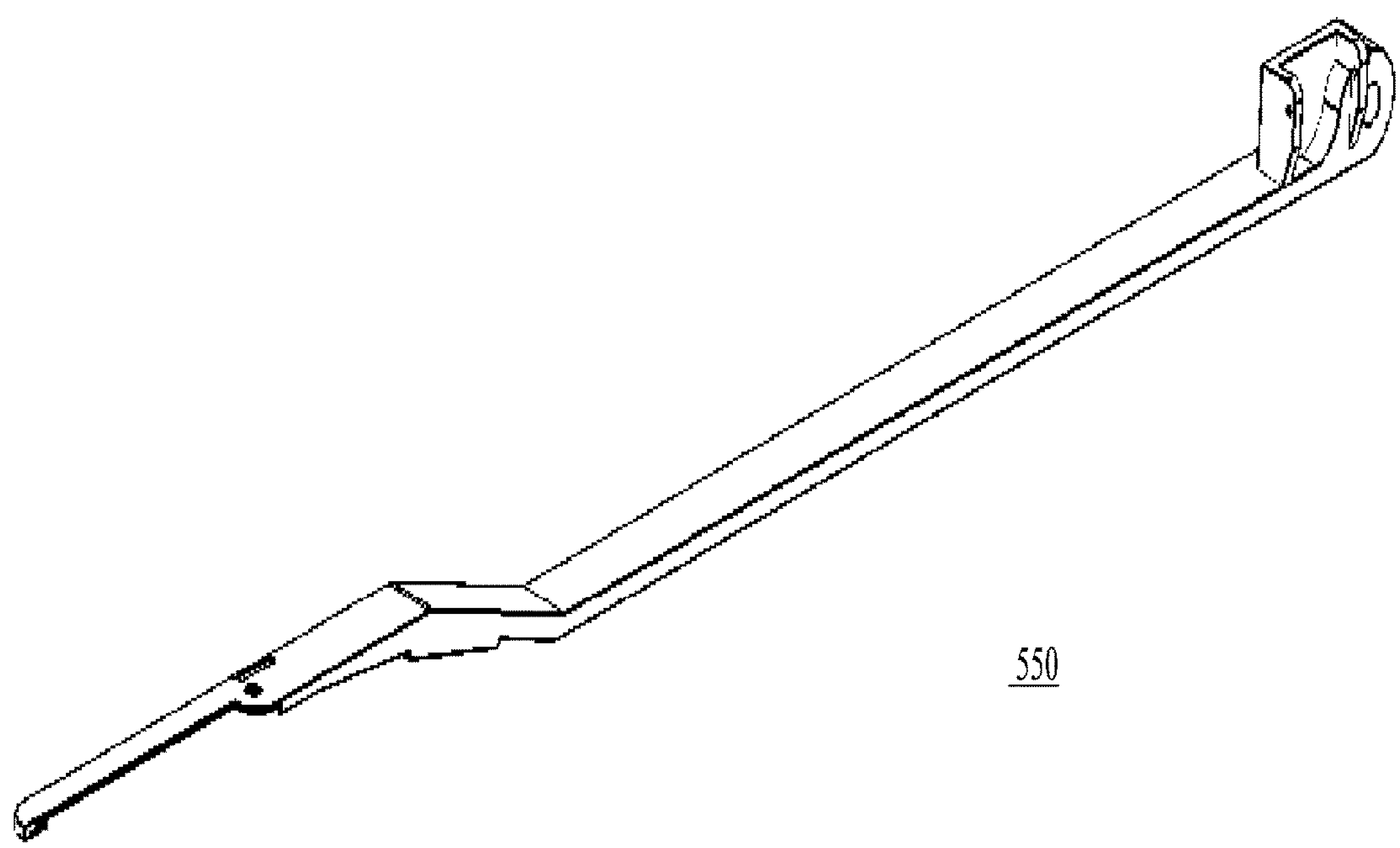


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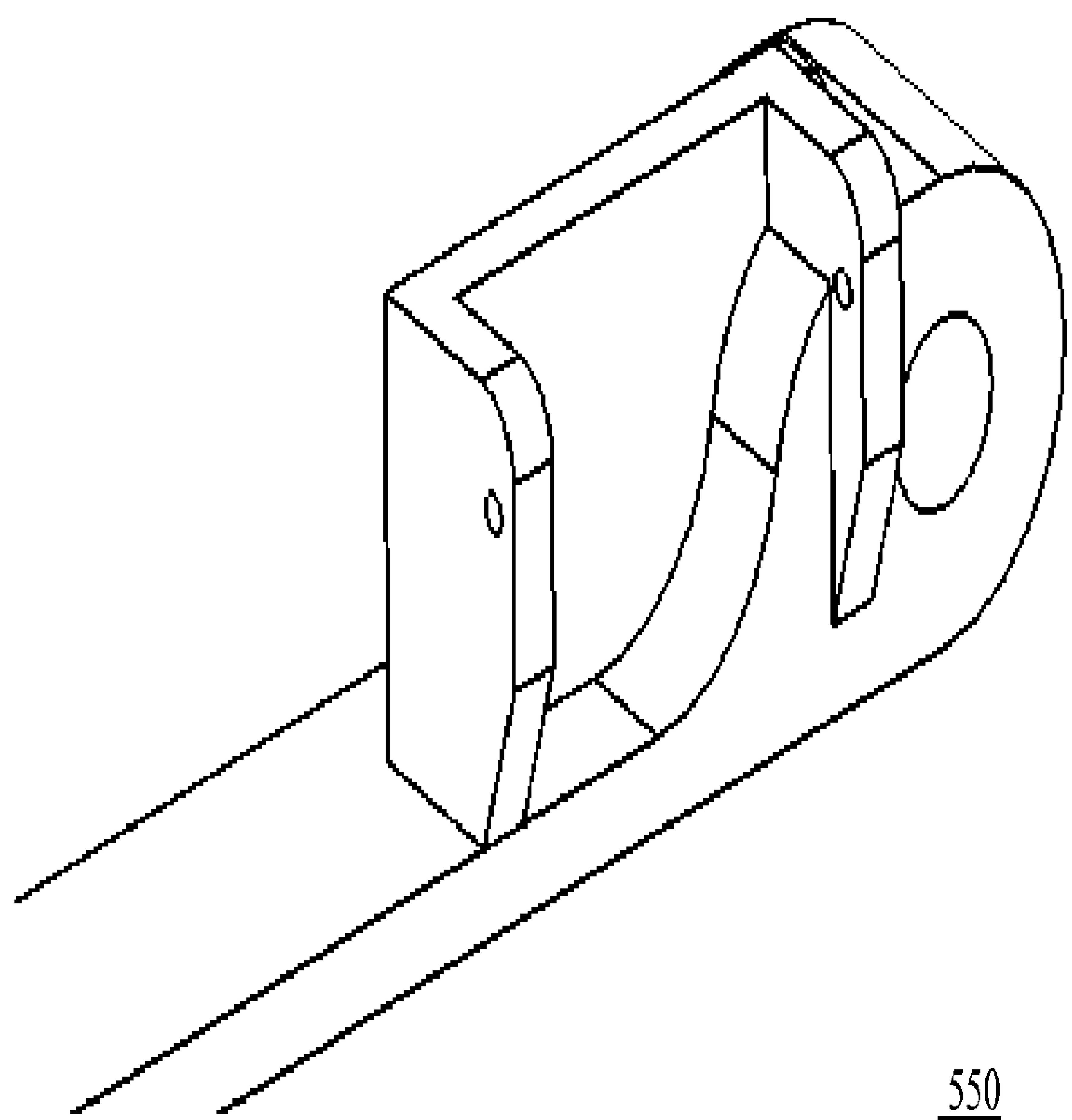


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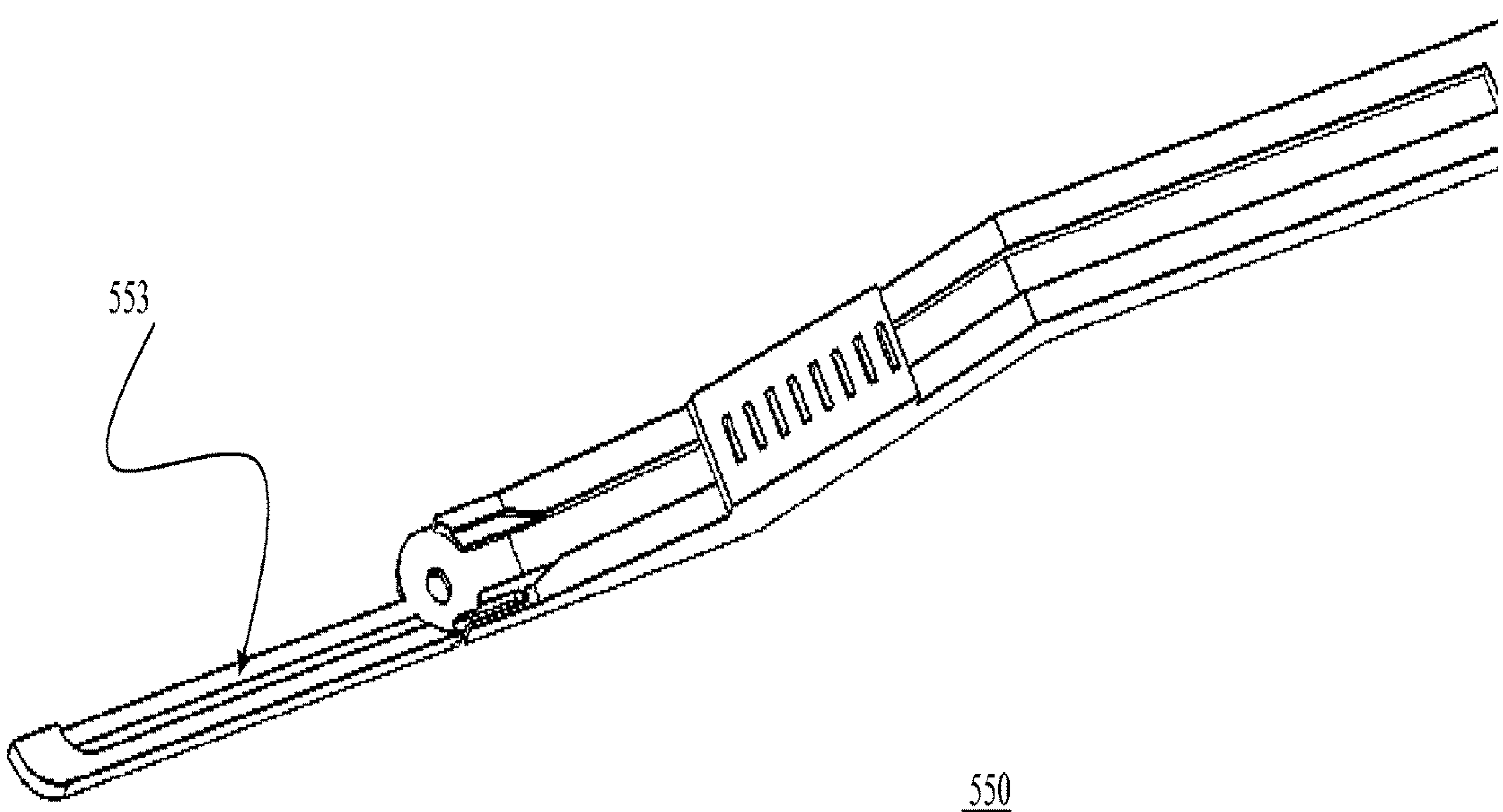


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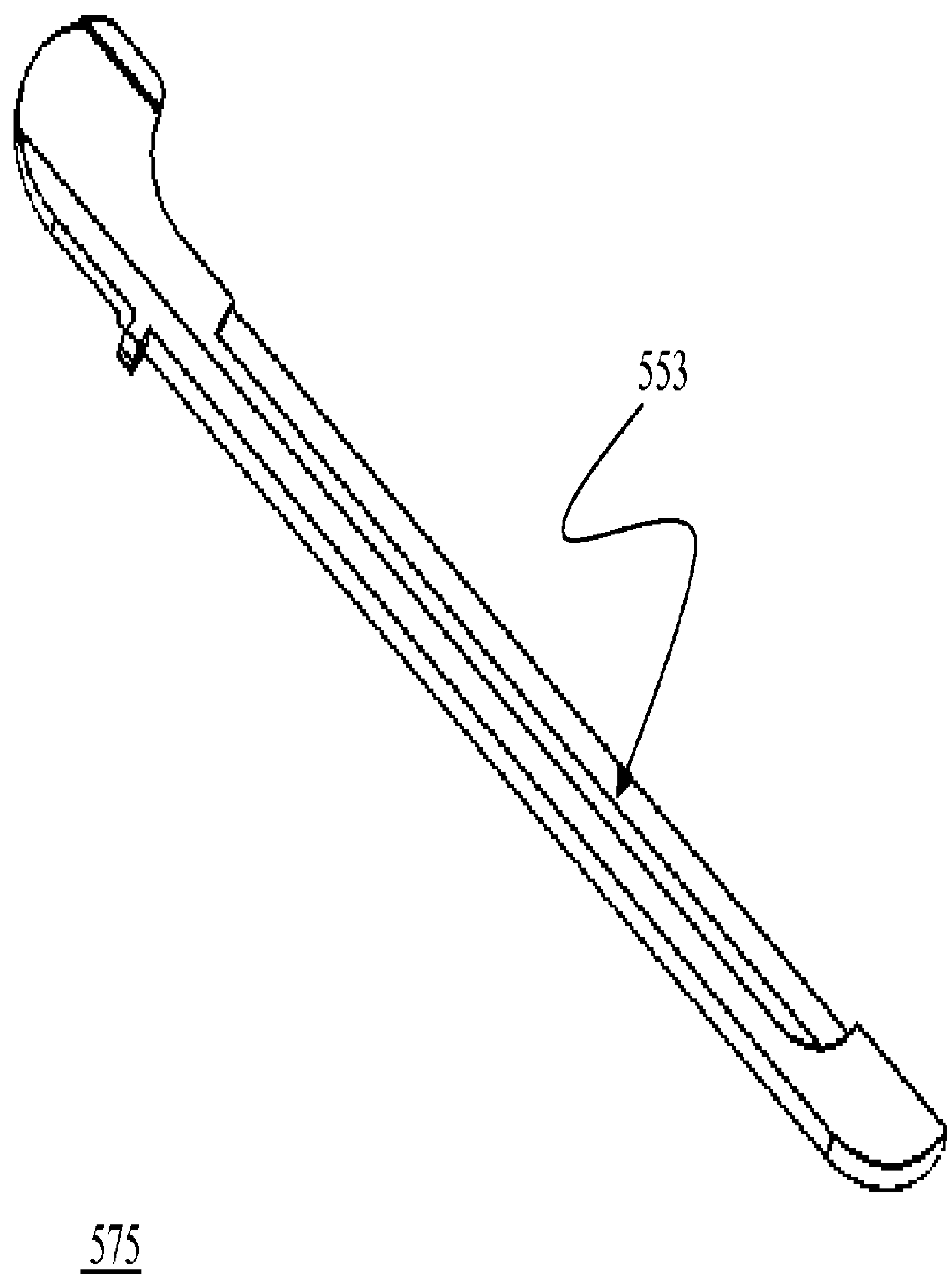


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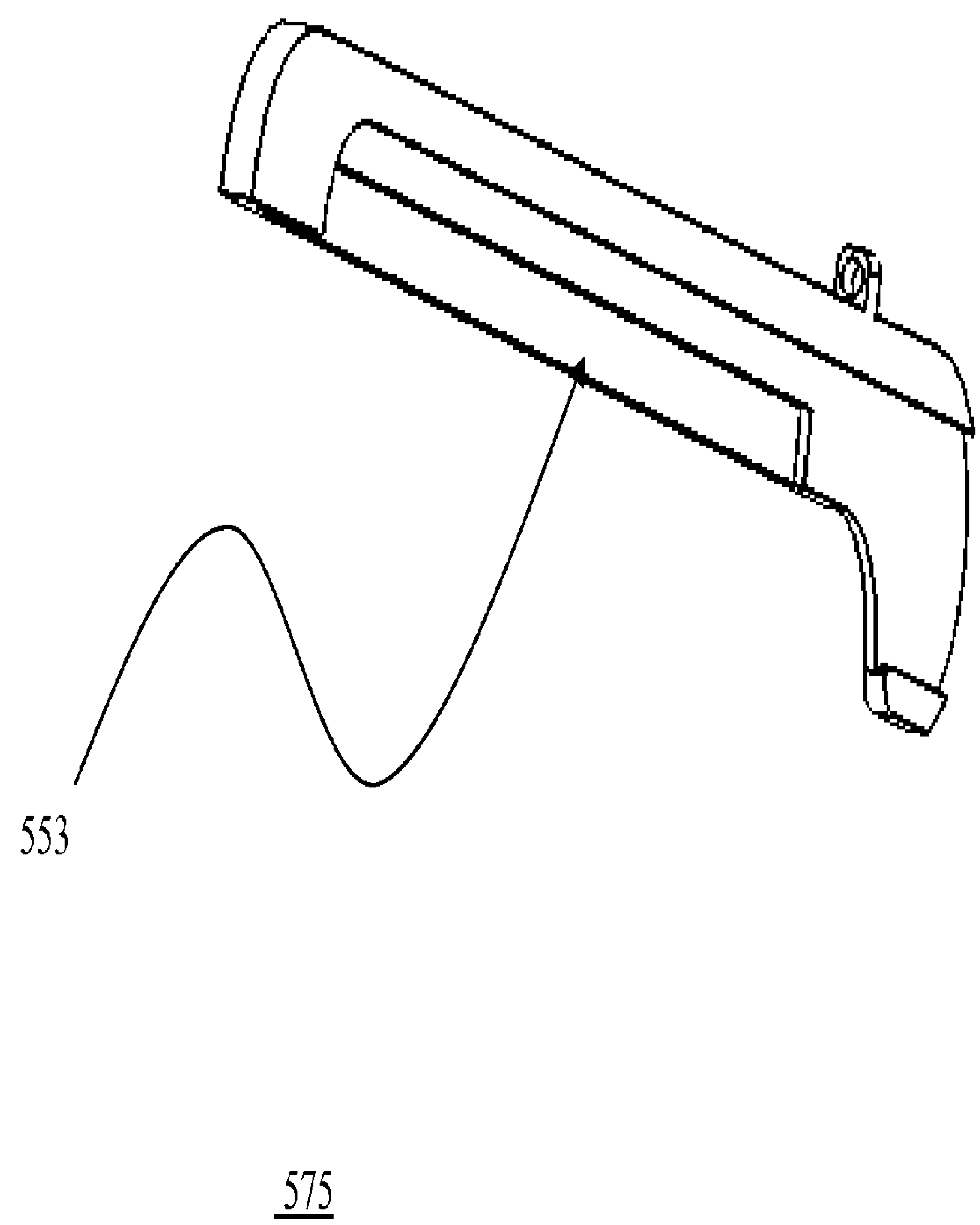


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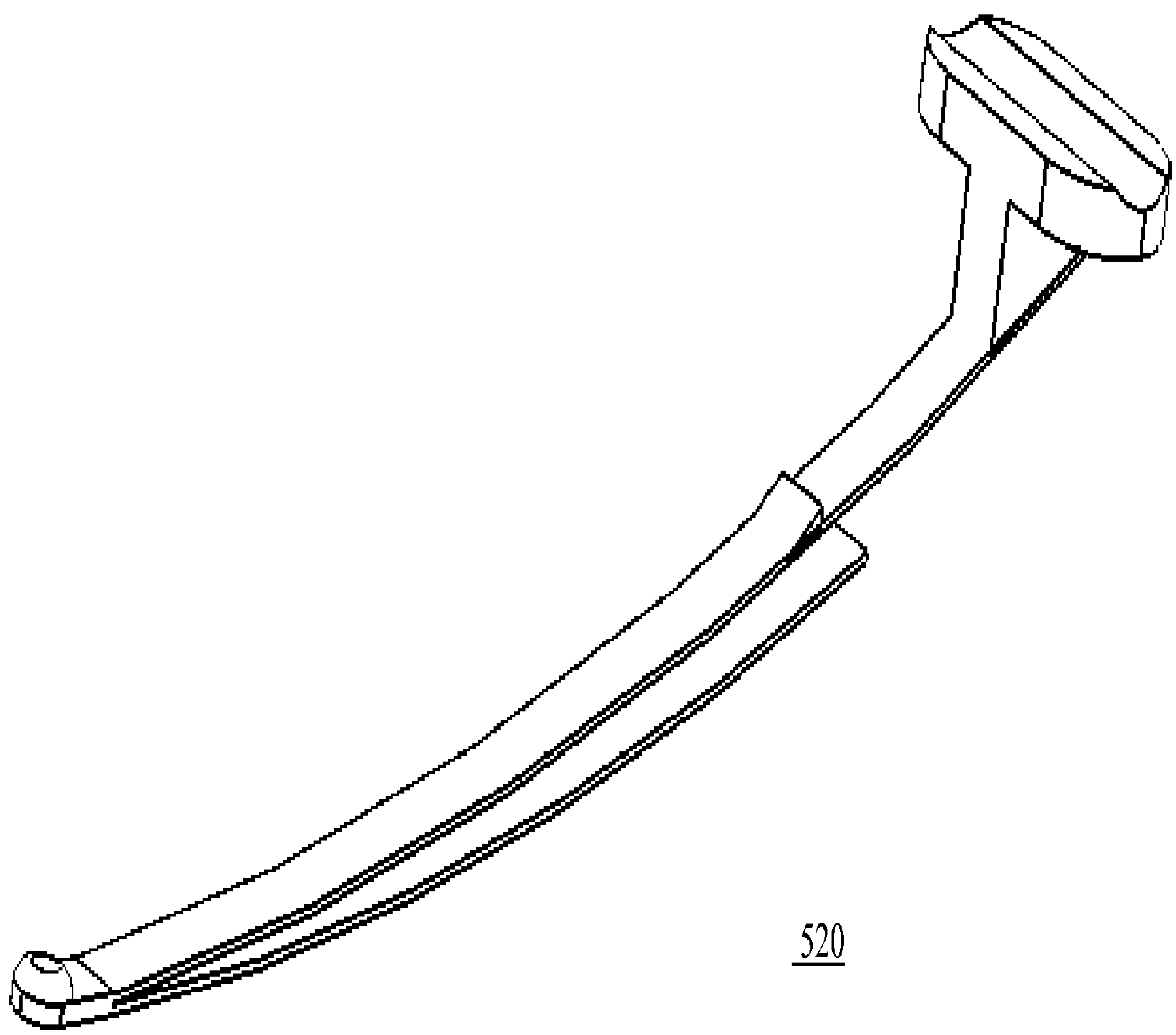


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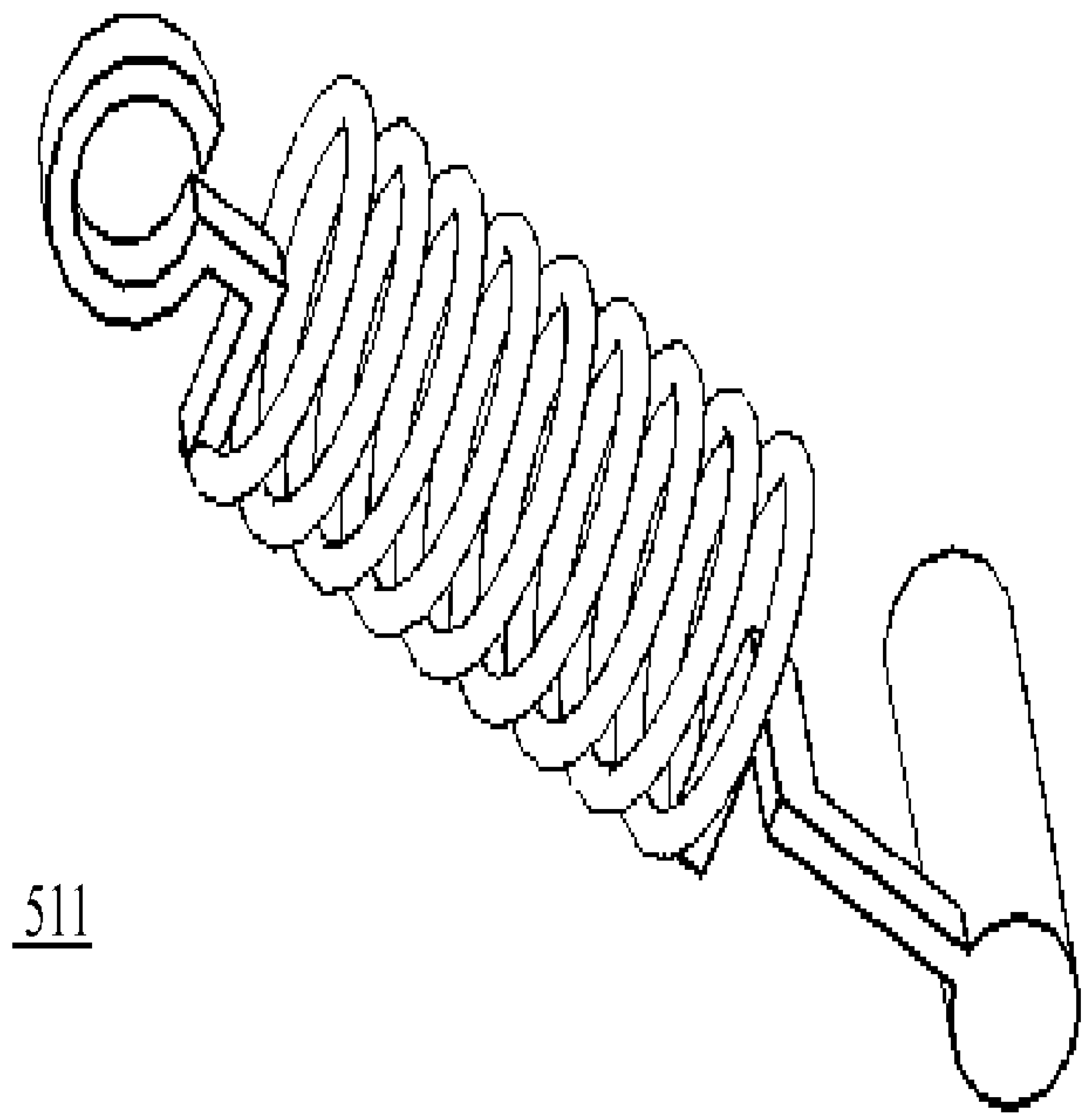


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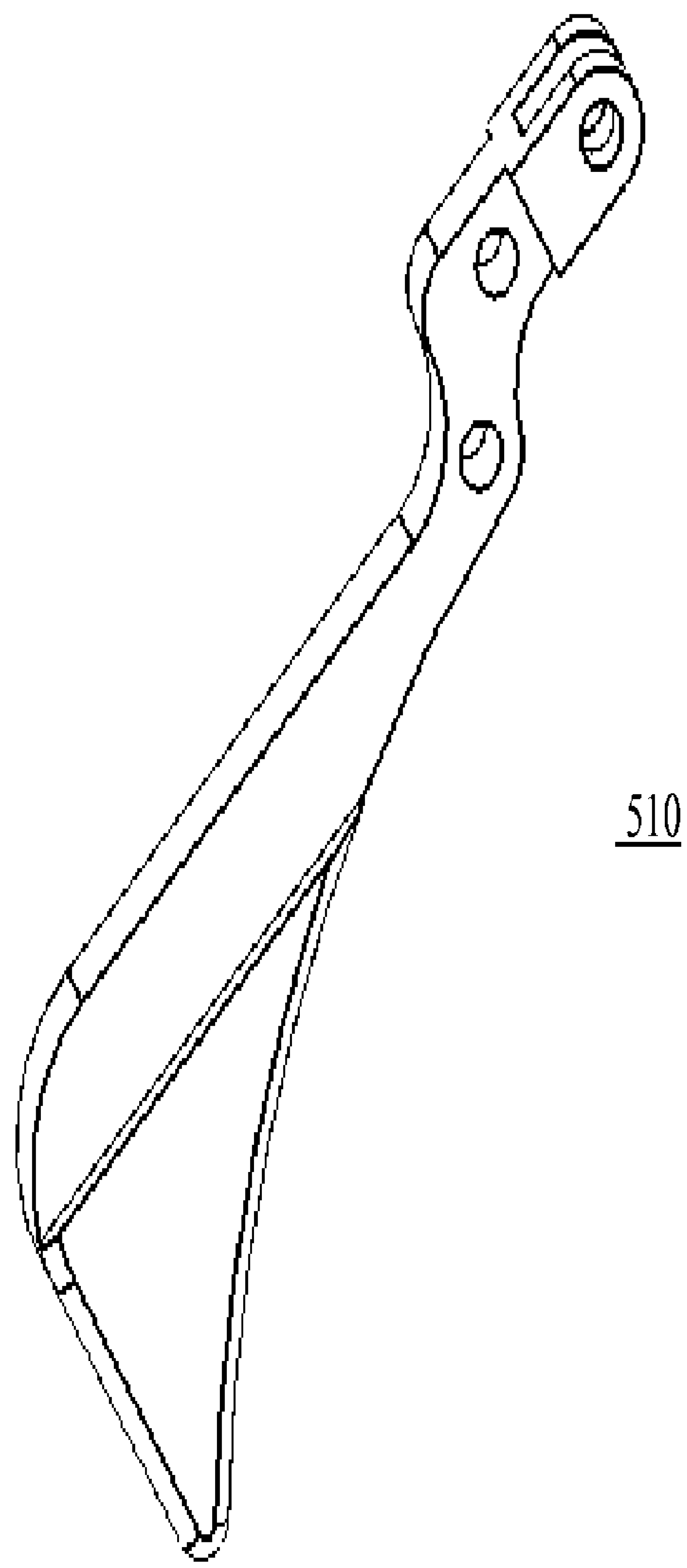


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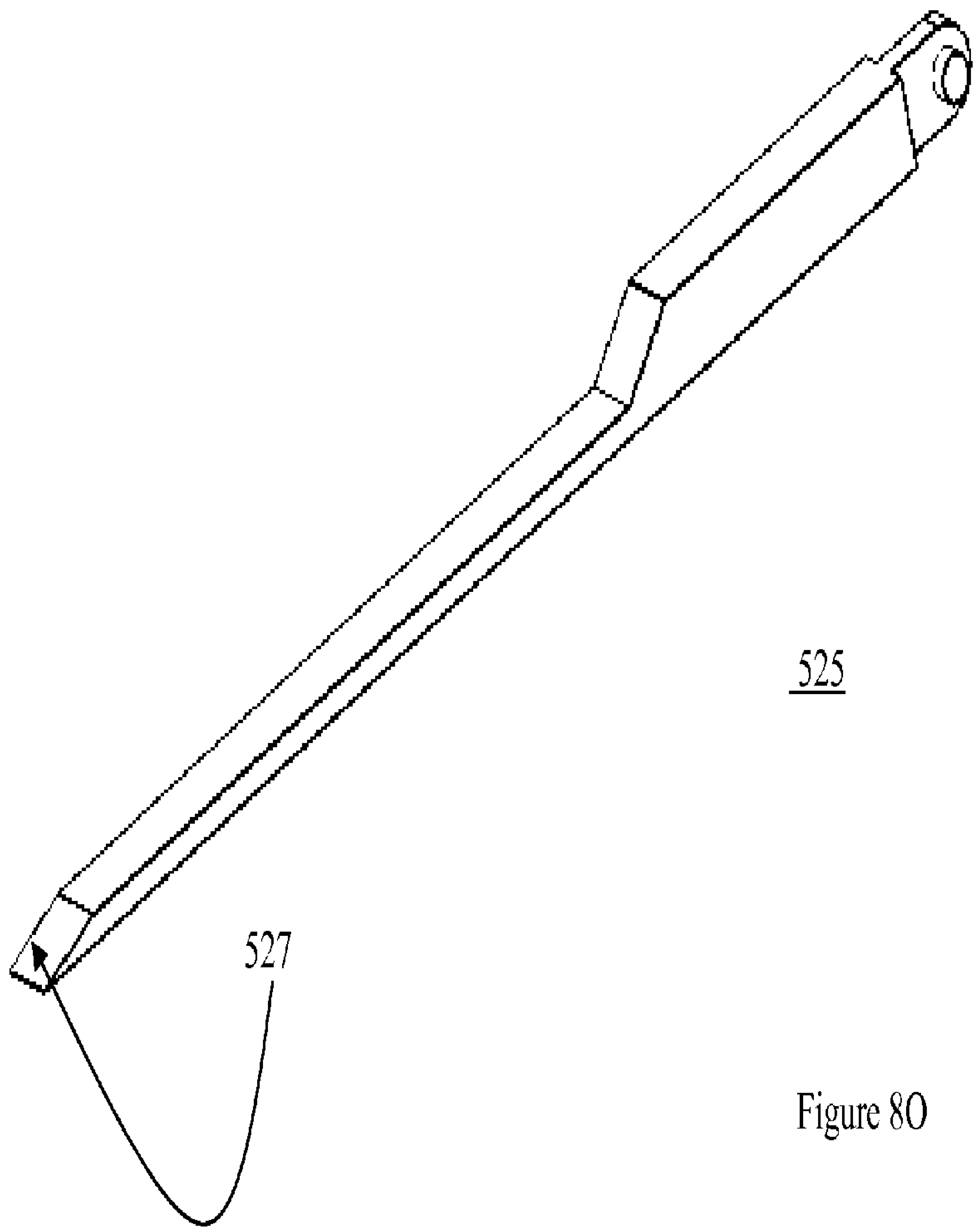


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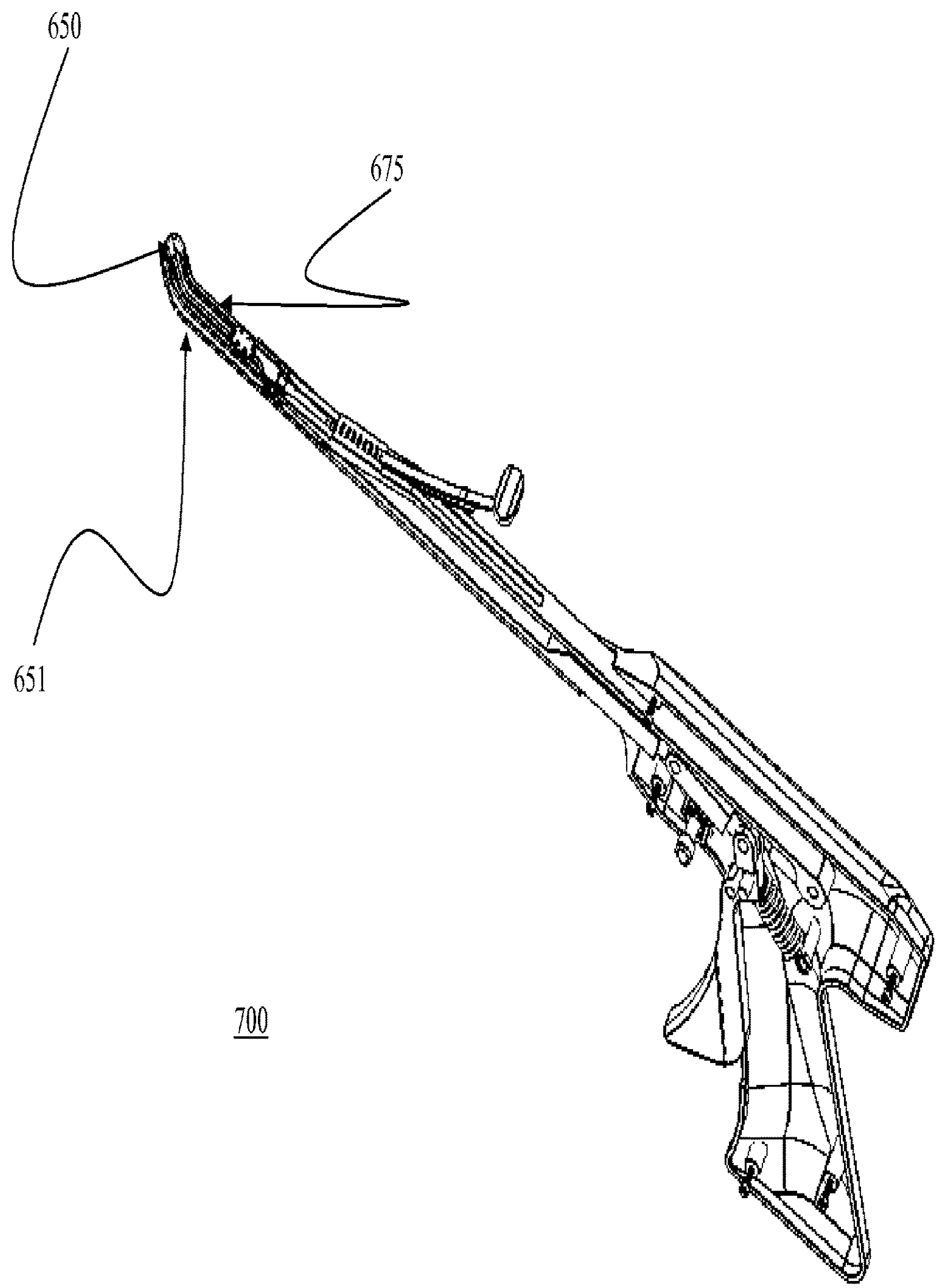


Figure 9A

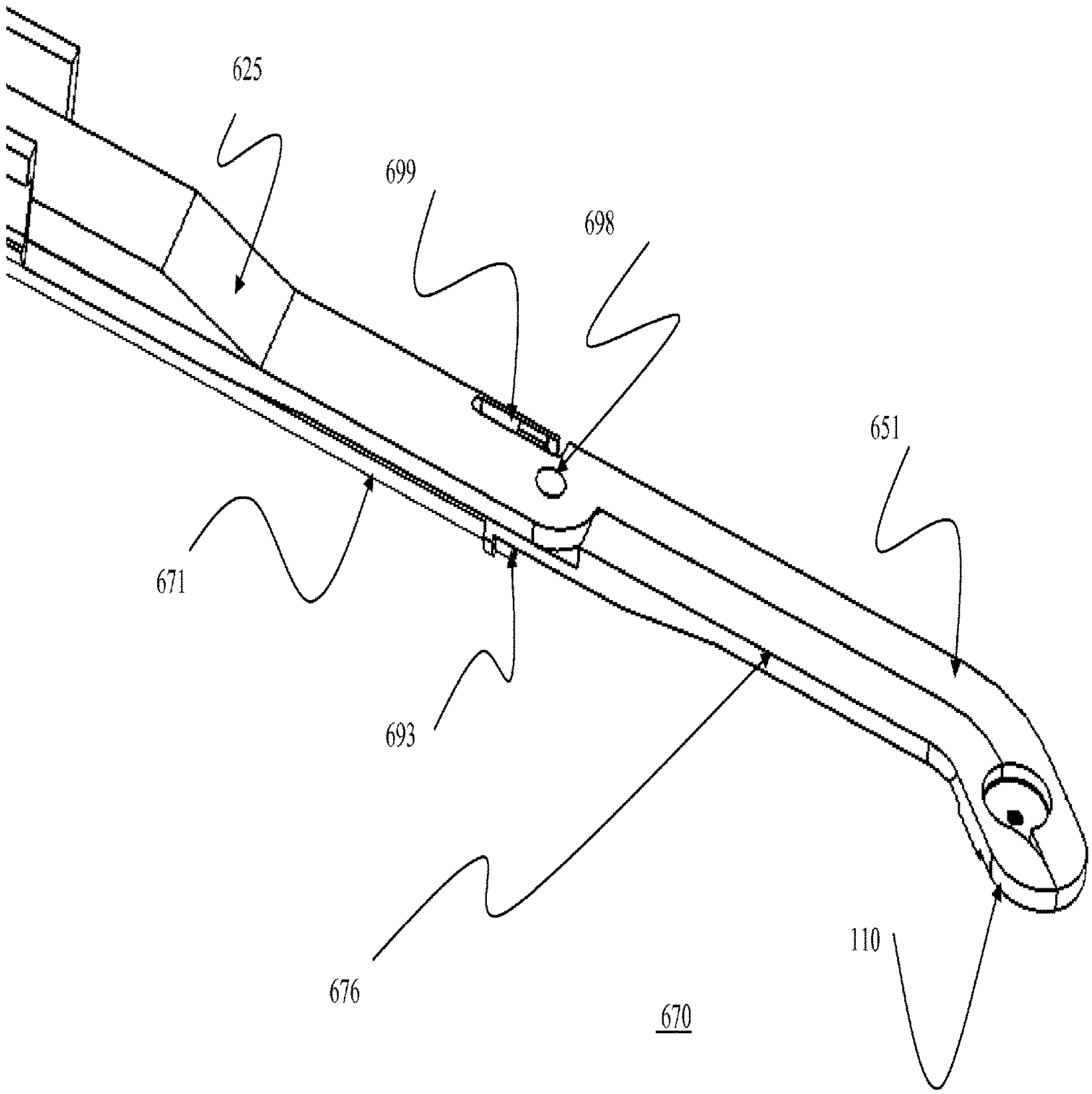


Figure 9B

# ARTIFICIAL CERVICAL AND LUMBAR DISCS, DISC PLATE INSERTION GUN FOR PERFORMING SEQUENTIAL SINGLE PLATE INTERVERTEBRAL IMPLANTATION ENABLING SYMMETRIC BI-DISC PLATE ALIGNMENT FOR INTERPLATE MOBILE CORE PLACEMENT

## CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a Continuation of U.S. application Ser. No. 14/739,327, filed Jun. 15, 2015, which is a Continuation of U.S. application Ser. No. 13/893,326, filed May 13, 2013 (now U.S. Pat. No. 9,056,018), which is a continuation of Ser. No. 11/943,334, filed Nov. 20, 2007 (now U.S. Pat. No. 8,535,379), which is a Continuation-in-part of U.S. application Ser. No. 11/487,415, filed Jul. 17, 2006 (now U.S. Pat. No. 7,854,766), which is a Continuation-in-part of Ser. No. 11/019,351, filed Dec. 23, 2004 (now U.S. Pat. No. 7,083, 650) and claims priority to 60/788,720, filed Apr. 4, 2006.

U.S. application Ser. No. 11/019,351 is a Continuation-in-part of Ser. No. 10/964,633, filed Oct. 15, 2004, and claims priority to U.S. Application Nos. 60/570,098, filed May 12, 2004; 60/570,837, filed May 14, 2004; 60/572,468, filed May 20, 2004; 60/573,346, filed May 24, 2004; and 60/578,319, filed Jun. 10, 2004. The entire contents of all of the above identified patent applications are hereby incorporated by reference.

## BACKGROUND

This description relates to a three piece mechanical total cervical artificial disc, which includes two spiked cervical plates and a mobile core. The disc may be inserted into the cervical intervertrebral disc space using a novel disc plate insertion gun which performs sequential single plate intervertebral implantation enabling symmetric bi-disc plate alignment for inter plate mobile core placement. This cervical disc design and method of implantation avoid the cumbersome and arduous implantation techniques of many other artificial cervical disc designs improving safety, improving bone-plate insertion/integration, allowing multiple-level disc placement, preserving vertebral body integrity, eliminating the need for excessive disc space distraction, and decreasing procedure length. This description also relates to a modified application of the disc plate inserter design from copending, related applications describing posterior placed total artificial disc (PTTLAD). The modified disc plate inserter allows posterior lumbar sequential placement of two opposing disc plates rather than simultaneous two disc plate placement as outlined in our previous publication. The modified disc plate inserter enables implantation of the PTTLAD into narrower lumbar disc spaces which were not accessible with our previous lumbar disc plate inserter.

Cervical and lumbar discs are entering the clinical neurosurgical and orthopedic markets. The benefits of these artificial discs are well known and have been thoroughly reviewed in our prior and co-pending prosthetic disc patents, including Provisional Application 60/788,720 filed on Apr. 4, 2006, copending U.S. patent application Ser. No. 11/019, 351, filed on Dec. 23, 2004 and Ser. No. 10/964,633, filed on Oct. 15, 2004, U.S. Provisional Application Nos. 60/578,319 filed on Jun. 10, 2004, 60/573,346 filed on May 24, 2004, 60/572,468 filed on May 20, 2004, 60/570,837 filed on May 14, 2004, and 60/570,098 filed on May 12, 2004, and U.S. patent application Ser. No. 11/487,415 filed on Jul. 17, 2006, the entire contents of each of which are hereby incorporated by reference. In one or more of the foregoing applications, we described four different cervical artificial disc embodiments which expanded in two or three-dimensions. This description presents an evolutionary simplification of these embodiments, e.g., with fewer small parts, which expand in only one dimension, and can be inserted very simply and efficiently. Accordingly, the advanced cervical disc design of the present application is a geometric modification of previous lumbar disc designs in one or more of the above-referenced patents, e.g., U.S. Patent Publication No. 2007/0198089 A1.

The cervical disc design of the present application differs from approaches of the background art which typically describe two-piece designs, e.g., as opposed to the three disc designs of the present application. In the two-piece designs, one piece consists of either an upper or lower cervical disc plate with a central trough to accommodate the opposing disc plate. The other piece, the opposing disc plate, has an incorporated dome shaped immobile core. The immobilized core is stationary and does not move. Semi-constrained artificial motion occurs as a result of the troughed plate movement against and around the immobilized core.

One or more of these designs are described in the following exemplary patent documents, including U.S. Pat. No. 5,314,477, filed Mar. 4, 1991 (Thierry Marnay), entitled "Prosthesis for intervertebral discs and instruments for implanting it;" U.S. Pat. No. 6,113,637 (Gill et al.), filed Oct. 22, 1998, entitled "Artificial intervertebral joint permitting translational and rotational motion; U.S. Pat. No. 6,540,785 B1 (Gill et al.) filed on Mar. 24, 2000, entitled "Artificial intervertebral joint permitting translational and rotational motion;" U.S. Pat. No. 6,8899,735 B2 (Bradley J Coates et. al.) filed on Oct. 2, 2002, entitled "Modular intervertebral prosthesis system," U.S. Pat. No. 6,908,484 B2 (Zubok et. al.) filed on Mar. 6, 2003, entitled "Cervical disc replacement." In each of the foregoing two-piece designs of the background art, the artificial implant is implanted within the vertebral bodies either by using attached hinges, keels or some form of extension which accommodates placement of vertebral screws.

The present inventors have determined that one disadvantage of most of these systems is that placement of the prosthesis is arduous, and time consuming, and can destroy a substantial part of the vertebral body after insertion of the device. The designs that use screws have the potential risks of screw pull out and secondarily esophageal injury, screw breakage, and/or inability to perform multilevel disc placement. Furthermore the fact that these designs do not have a mobile core leads to substantially constrained motion.

Similarly, U.S. Patent Publication No. 2007/0173936 A1 (Hester) filed on Jan. 23, 2006, describes a design which includes spikes, also includes a two-piece design with an immobilized core. One or more embodiments of the present application includes a mobile core which more closely simulates natural semi-constrained motion of a healthy cervical disc. U.S. Patent Publication No. 2005/0021146 A1 (de Villiers et al.) filed May 26, 2004 consists of two separate plates placed which are inserted simultaneously as one unit, after which a mobile core is inserted in between the plates. However, the plates include keels which can damage vertebral bodies, and prevent multilevel placement. U.S. Pat. No. 6,001,130 (Bryan), filed Oct. 6, 1997, describes a one piece design. However, the one-piece design involves an arduous placement technique involving disc space distraction, and the use of hinges and screws, limiting multi-level placement.

## SUMMARY

One or more of the embodiments of the present application overcome one or more of the above-described shortcomings of the background art. For example, a cervical disc design and tool for implantation of the cervical disc is an improvement over one or more of the above mentioned designs of the background art. Specifically, the spikes allow integration into the vertebral body, e.g., with relatively small spikes, without damaging the vertebral bodies. This is particularly important if future prosthetic or fusions need to be performed at that level. The cervical plates are inserted sequentially with a novel cervical plate insertion gun. The advantage of the cervical plate insertion gun is that the method of implantation is quick and efficient. No disc space distraction is needed and hence there is no fear of damaging or disarticulating posterior cervical facets. It can also be placed into narrower spaces without distraction. The mobile core of the present application also more closely approximates the natural semi-constrained motion of a healthy disc more so than the above mentioned discs.

Additional advantages of our posterior placed total lumbar artificial disc (PTTLAD) lumbar disc design have been fully reviewed in our co-pending patents, each of which have been incorporated by reference herein. The present lumbar disc plate inserter design offers two additional advantages over previous embodiments. First, the inserter design grasps the plates more securely. In addition, the sequential placement of the different plates allows placement of posterior artificial discs into narrower disc spaces.

In one general aspect, an artificial spinal disc includes a pair of substantially parallel plates formed to occupy a space defined by vertebral endplates. Each of the plates including a plurality of spikes on a first surface and a concave trough formed on a second surface opposite of the first surface. A mobile core includes a core rim with opposing convex surfaces extending from opposite sides of the core rim, the mobile core being capable of being disposed between the pair of plates to permit the vertebral endplates to move relative to one another. The spikes on each of the plates extend substantially away from the mobile core and the convex surfaces are formed to integrally fit within the concave trough of at least one of the plates. The core rim limits lateral movement of the mobile core relative to the parallel plates.

Implementations of this aspect may include one or more of the following features. For example, the plates and mobile core can be sized and shaped to integrally fit within a space defined by cervical vertebral endplates and/or lumbar vertebral endplates. Each trough can be disposed in a center of each respective, parallel plate. The troughs can be shaped to receive the convex surfaces of the mobile core and the core rim can be shaped to receive outer edges of the troughs with an integral fit. The substantially parallel plates can include a plurality of conically shaped spikes.

The mobile core rim may include at least a first substantially ring shaped member having a raised edge and a second substantially ring shaped member having a raised edge. The first and second ring shaped members may each define respective cavities where the convex surfaces are respectively positioned within and extend from. The plates can comprise an elliptical shape.

In another general aspect, an artificial disc insertion system includes an artificial disc having a pair of substantially parallel plates formed to occupy a space defined by vertebral endplates, each of the plates including a plurality of spikes on a first surface and a concave trough formed on a second surface opposite of the first surface. The disc includes a mobile core having a core rim with opposing convex surfaces extending from opposite sides of the core rim, the mobile core being capable of being disposed between the pair of plates to permit the vertebral endplates to move relative to one another. The spikes on each of the plates extend substantially away from the mobile core and the convex surfaces are formed to integrally fit within the concave trough of at least one of the plates. The core rim limits lateral movement of the mobile core relative to the parallel plates. The system also includes a surgical tool.

The surgical tool for inserting the artificial disc between vertebral endplates, the tool includes a handle portion having a trigger, an upper disc plate release button, and a lower disc plate release button. The surgical tool also includes an insertion portion extending distally away from the handle portion, the insertion portion includes an upper replacement plate releasing portion and a lower replacement plate releasing portion. The upper replacement plate releasing portion includes a release handle and a release link configured to engage and release a periphery of an upper replacement plate, e.g., to releasably secure the upper replacement plate therebetween. The lower replacement plate releasing portion includes a release handle and a release link configured to engage and release a periphery of a lower replacement plate, e.g., to releasably secure the lower replacement plate therebetween.

Implementations of this aspect may include one or more of the following features. For example, the mobile core and plates can be sized and shaped for a cervical disc replacement. The mobile core and the plates can be sized and shaped for a lumbar disc replacement. The mobile core rim may include at least a first substantially ring shaped member having a raised edge and a second substantially ring shaped member having a raised edge. The first and second ring shaped members may each define respective cavities where the convex surfaces are respectively positioned within and extend from. The plates can include an elliptical shape.

In another general aspect, a surgical tool for inserting an artificial disc between vertebral endplates includes a handle portion comprising a trigger, an upper disc plate release button, and a lower disc plate release button. The tool also includes an insertion portion extending distally away from the handle portion, the insertion portion comprising an upper replacement plate releasing portion and a lower replacement plate releasing portion. The upper replacement plate releasing portion includes a release handle and a release link configured to engage and release a periphery of an upper replacement plate, e.g., to releasably secure the upper replacement plate therebetween. The lower replacement plate releasing portion includes a release handle and a release link configured to engage a periphery of a lower replacement plate, e.g., to releasably secure the lower replacement plate therebetween.

Implementations of this aspect may include one or more of the following features. For example, the insertion portion may include an upper tip portion and a lower tip portion. The upper tip portion and the lower tip portion may be curved to facilitate posterior insertion of a lumbar replacement disc in a patient. At least one of the upper or lower replacement plate releasing portions can include a leaf spring, a tension cable and a wedge portion proximally disposed relative to the respective release handle and the release link. Each of the upper and lower replacement plate releasing portions can include a leaf spring, a tension cable and a wedge portion proximally disposed relative to the respective release handle and the release link. The tool can include a replacement disc plate driver portion for driving a replacement disc plate from a first, proximal position toward a second, distal position. The upper replacement plate releasing portion is configured to secure an upper replacement plate in a position opposite from and axially aligned with a center of a lower replacement plate held within the lower replacement releasing portion.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**A is an anterior (or posterior) view of an exemplary cervical artificial disc.

FIG. **1**B is an isometric view of the cervical artificial disc of FIG. **1**A.

FIG. **1**C is an exploded view of the cervical artificial disc of FIG. **1**A.

FIG. **1**D is a superior (or inferior) view of the cervical artificial disc of FIG. **1**A.

FIG. **2**A is a side view of an exemplary cervical artificial disc mobile core.

FIG. **2**B is an isometric view of the exemplary cervical artificial disc mobile core.

FIG. **2**C is a front (or back) view of the exemplary cervical artificial disc mobile core.

FIG. **3**A is a side view of an exemplary cervical artificial disc superior or inferior plate.

FIG. **3**B is a top oblique-trough side view of the exemplary cervical artificial disc superior or inferior plate.

FIG. **3**C is a top oblique-spike view of the exemplary cervical artificial disc superior or inferior plate.

FIG. **3**D is a front-trough side view of the exemplary cervical artificial disc superior or inferior plate.

FIG. **3**E is a front-spike side view of the exemplary cervical artificial disc superior or inferior plate.

FIG. **4**A is a cross-sectional view of a cervical disc core showing the angular movements about the x-axis of the cervical disc core with respect to the upper and lower cervical plates (lateral bending).

FIG. **4**Bi is a front view of later cervical disc bending.

FIG. **4**Bii is a side view of flexion/extension cervical artificial disc motion.

FIG. **4**Ci is a front view of the artificial disc showing the rotations of the mobile core between the two cervical disc plates about the x-axis (lateral bending or roll).

FIG. **4**Cii is a side view of the artificial disc showing the y-axis (flexion/extension or pitch).

FIG. **4**Ciii is a perspective view of the artificial disc showing the z-axis (rotation or yaw).

FIG. **5**A is a front view of a cervical disc plate insertion gun.

FIG. **5**B is a top view of the cervical disc plate insertion gun.

FIG. **5**C is a bottom view of the cervical disc plate insertion gun.

FIG. **6**A is a perspective, left-side, cut-away view of the cervical disc plate insertion gun.

FIG. **6**B is a left side, bottom angle view of the cervical disc plate insertion gun.

FIG. **6**C is a right side, top angle view of the cervical disc plate insertion gun.

FIG. **6**D is a right side, bottom angle view of the cervical disc plate insertion gun.

FIG. **6**E is a cut-away view of the tool tip lower cervical disc replacement plate release mechanism.

FIG. **7**A is a view of an outside left enclosure of the cervical disc plate insertion gun.

FIG. **7**B is a view of an inside left enclosure of the cervical disc plate insertion gun.

FIG. **7**C is a view of an outside right enclosure of the cervical disc plate insertion gun.

FIG. **7**D is a view of an inside right enclosure of the cervical disc plate insertion gun.

FIG. **8**A is a top view of inner components of the cervical plate insertion gun including the lower insertion handle.

FIG. **8**B is a lower insertion handle bottom view.

FIG. **8**C is top view of a lower insertion link.

FIG. **8**D is bottom view of the lower insertion link.

FIG. **8**E is a view of the wedge link.

FIG. **8**F is a top view of the upper insertion handle.

FIG. **8**G is a lower view of the upper insertion handle lower view.

FIG. **8**H is a close-up bottom view of a rear portion of the upper insertion handle.

FIG. **8**I is a close-up, top view of a forward portion of the upper insertion handle.

FIG. **8**J is a top view from left of the upper insertion release link.

FIG. **8**K is a top view from a right side of the upper insertion link.

FIG. **8**L is a view of a manual upper disc replacement plate driver.

FIG. **8**M is a view of a trigger spring.

FIG. **8**N is a view of a trigger.

FIG. **8**O is a view of a wedge.

FIG. **9**A is a perspective cut away view of an exemplary lumbar disc plate insertion gun.

FIG. **9**B is a cut-away view of the tool tip of the lower lumbar disc replacement plate release mechanism.

## DESCRIPTION OF PREFERRED EMBODIMENTS

The Medical Device of FIG. **1-9**.

Referring now to FIGS. **1-9**, the above described problems of the background art can be solved in the cervical spine (and lumbar spine) after the performance of an anterior complete cervical discectomy. The disc device **10** includes an upper cervical plate **100** and lower cervical plate **110**, one of which is inserted first by a plate insertion gun **500**. The opposite (second) cervical disc plate **110** is then inserted with the plate insertion gun **500** maintaining parallel opposition, with opposite plates **100**, **110** and troughs **102**, **112** perfectly aligned. A mobile core **150** is then inserted and sandwiched in-between both cervical plates **100**, **110**.

FIGS. **1**A-D illustrate different views of the cervical artificial disc **10**. The disc **10** includes an upper plate **100** and a lower plate **110**. Each plate has a plurality of spikes **101**, **111**, e.g., six spikes **101**, **111** on each plate in a preferred embodiment, on an outer surface of the respective plate, and a centralized trough **102**, **112** on an inner surface of each plate **100**, **110**.

FIGS. **2**A-C illustrate different views of the cervical mobile core **150**. The core **150** has a centralized base rim **151** with a superior convexity **152** which interacts with the trough **102** of the upper plate **100**, and an inferior convexity **153** which interacts with the trough **112** of the lower plate **110**.

FIGS. **3**A-E illustrate different views of the cervical plate (superior or inferior) **100** (**110**). The plate **100** includes a base **114**. On an upper surface of the inferior plate **110** is a trough **112**. On a lower surface of the inferior plate **110** are 6 peripherally arranged spikes **111**. The position of the trough **112** and spikes **111** are reversed for the superior plate (**100**). A groove **113** is defined by the trough **112** (**102**) and base **114** (**104**) of each plate **110** (**100**).

FIG. **4**A illustrates a cross-sectional view of the cervical artificial disc **10** and the degrees of motion of the mobile core **150** movement about the x-axis with respect to the upper plate **100** and lower plate **110**. Each disc plate **100** can bend about the x axis by 4.39 degrees clockwise and counter-clockwise (lateral bending). This means that a disc plate **100**, **110** can move – or +8.78 degrees with respect to the opposite plate **110**, **100**.

FIG. **4**B illustrates a front view of lateral bending of the artificial disc **10** (FIG. **4**Bi), and a side view illustrating flexion-extension of the cervical disc **10** about the y axis which is 4.39 degrees in either flexion or extension.

FIG. **4**C illustrates the rotation of the mobile core **150** between two cervical plates **100**, **110** about the x (FIG. **4**Ci), y (FIG. **4**Cii) and z (FIG. **4**Ciii) axes. Rotation about the x-axis is referred to as roll (alpha) which is lateral bending. Rotation about the y axis is referred to as pitch (Beta) which is flexion/extension. Rotation about the z axis is referred to as yaw (gamma) which is axial rotation. These figures display different views that show a reference frame for the disc assembly **10** with an origin O at the center of the core **150**. The axes of rotation pass through the spherical face of the core **150** which is lower than 0 but are parallel to both the x and y axes. The rotation of the disc plates **100**, **110** about the z-axis is constrained only by the spine motions once the disc **10** is implanted.

FIGS. **5**-**8** illustrate the components of the cervical disc plate insertion gun **500**. Various opening mechanism functions will be described in greater detail hereinafter with respect to FIGS. **5**-**8**. The handle **512** of the opening mechanism is made up of left and right enclosures **501**, **502** (FIGS. **5**, **6**, and **7**). FIG. **7** illustrates the inside and outside aspects of left and right enclosures **501**, **502**. These enclosures **501**, **502** are held together by five enclosure fastening screws **590** (FIG. **6**B). The handle **512** holds the mechanism used to insert the upper disc plate **100** and lower disc plate **110** (FIGS. **5**-**6**, and FIG. **8**) into the vertebrae. The mechanism has two functions, including: 1) Holding onto the disc plates **100**, **110** until the user releases them, and 2) opening the tip **560** and forcing one disc plate at a time into a vertebra.

1. Holding onto the Discs Until User Releases them

The mechanism has two tips **565**, **580** each holding a disc plate **100**, **110**. The lower tip **580** is composed of two parts: the lower insertion release link **576** and the lower insertion release handle **551** (FIGS. **6** and **8**). The upper tip **565** includes two parts: the upper insertion handle **550** and the upper insertion link **575** (FIGS. **6** and **8**). Each tip **565**, **580** works like a “lobster claw” that holds a disc plate by the “groove” **552** on its cylindrical extrusion. When the tip **565**, **580** is closed the two opposing parts e.g. the lower insertion release link **576** and the lower insertion release handle **551** (FIGS. **6** and **8**) hold a disc plate **110** firmly.

A tip **580** opens to release a disc plate as follows. A lower tension cable **571** pulls on the lower insertion release link **576** (FIGS. **6** and **8**) that pivots about the lower release pin **598** (FIG. **6**) and opens up a gap big enough to loosen the grip on the disc groove **552**. The lower tension cable **571** (FIG. **6**) can only exert a tensile force to open the lobster claw **580**. The natural state of the lobster claw **580** is to be closed. This is ensured by pre-loading the lower insertion release link **576** with the help of a leaf spring **599** cut into the lower insertion release handle **551** (FIGS. **6**E and **8**). The lower tension cable **571** pulls on the lower insertion release link **576** (FIGS. **6** and **8**) each time the user presses on the lower release button **540**. The lower tension cable **571** is clamped on one end by a lower rear crimp **592** (FIGS. **6** and **8**). Hence when the lower release button **540** is pressed, the tension on the lower tension cable **571** increases (in the same way the tension of a guitar string increase when one presses on the string with a finger). The tension then pulls the lower insertion release link **576** forcing it to swing open. When the user lets go of the button **540**, the tension disappears and the spring **599** carved in the lower insertion release handle **551** forces the lower insertion release link **576** to swing closed (FIG. **6**E).

The upper tip **565** works in a similar fashion except that its opening is triggered by the upper release button **530**.

2. Opening its Tip and Forcing One Disc at a Time into a Vertebra

The mechanism tips **565**, **580** open each time the user presses on trigger **510**. When the trigger **510** rotates, it pushes on the wedge link **513** which in turn pushes on the wedge part **525** (FIG. **8**). The wedge part **525** is wedged at its front action end that creates a gap in between the lower tool tip **580** and upper tool tip **565** forcing them to open.

A typical disc insertion operation starts with a lower disc plate **110** placed in the lower tip **580** and the opposing upper disc plate **100** placed on the upper side but away from the tip **565** (as shown in FIGS. **5**, **6**, and **8**). A channel **553** along the upper tip **565** that is formed by the upper insertion release handle **550** and the upper insertion release link **575** which holds the second disc plate **100** in place and serves to guide it to the tip **565** when needed.

Once the tool tip **560** is inserted into the inter-vertebral space, the first disc plate **100** is inserted into the lower vertebra by opening the tool tip **560**. To keep alignment, the lower tool tip **585**, “lower lobster claw”, is kept closed (FIG. **6**), securing the disc plate just inserted. The tool **500** should be left in place. The second, upper, disc **100** initially placed in the upper tool half, away from the “upper lobster claw” **565** but away from the tip is then slid down to the end of the upper lobster claw **565** by a flexible and manually activated upper disc replacement plate driver **520** (FIGS. **6** and **8**). Once the second disc **100** is positioned at the tip of the upper “lobster claw” **565** (FIG. **6**), the tool tip **560** is opened once more, i.e., the upper tip **565** and lower lobster claw tip **580** are separated from each other, by virtue of the wedge **525** that is activated by the trigger **510**, via wedge link **513** action. Once the second, upper, disc plate **100** is inserted, the user can press on the upper release button **530** and lower release button **540** to release both discs (by opening the upper and lower “lobster claws” **565**, **580**) and at the same time close the tool tip **560** (by releasing the trigger **510**). The tool tip **560** then closes while both “lobster claws” **565**, **580** remain open, leaving both disc plates **100**, **110** in place. The tool tip **560** can then be removed from the patient and a mobile core placed in between the two aligned disc plates **100**, **110**.

This anterior cervical disc gun can be modified and enlarged for placement of anterior lumbar disc plates. FIG. **9**A illustrates the modified posterior lumbar disc plate insertion gun **700**. The gun **700** is identical to the cervical disc plate insertion gun **500** except its tips **660** are angled to allow insertion of the specifically sized lumbar disc plates **100**, **110** in the posterior lumbar spine underneath the thecal sac.

FIG. **9**B illustrates an enlarged cut-away view of the tool tip **660** of the lumbar lower disc replacement plate release mechanism **670**. The mechanism **670** is identical to that described for the cervical mechanism which is illustrated FIG. **6**E. The tips **660** of the lumbar tool are however, specifically designed and adapted for the typically bean shaped lumbar disc plates.

The Surgical Method

The method of insertion of the cervical artificial disc (or lumbar artificial disc) into the anterior cervical spine can be performed open microscopically, or closed tubularly, using endoscopic and/or fluoroscopic guidance.

After the adequate induction of anesthesia the patient is positioned in the supine position. Routine exposure of the anterior cervical spine is performed and the appropriate disc space is radiographically identified and exposed. A routine complete anterior cervical discectomy is performed.

The cervical disc plates are inserted onto the cervical disc plate insertion gun **500**. The tips **560** of the gun **500** are placed into the intervertebral space. Fluoroscopy is used to assure centrality of disc plate placement.

The trigger **510** of the gun **500** is depressed and the bottom plate **110** is inserted into the lower vertebrae. Once this penetrates the bone, the lower plate releasing button **540** is depressed, thereby releasing the plate from the inserter claws **580** (FIG. **6**E). The second upper plate **100** is now manually driven into the space by the gun's manual plate driver **520**. Because of the design of the gun **500**, the upper plate **100** is perfectly aligned with the lower plate **110**. The gun trigger **510** is depressed and this drives the upper plate **100** into the upper vertebrae. The upper plate releasing button **530** is now depressed, releasing the upper plate **100** from the inserter lobster claws **565**. The gun **500** is removed from the interspace. A mobile core **150** of the appropriate height is selected and placed in between the upper and lower cervical disc plates **100**, **110**, respectively. The patient is closed routinely.

The surgical method for the posterior insertion of the PPLTAD into the posterior lumbar interspace can be performed open microscopically, or closed tubularly, using endoscopic and or fluoroscopic guidance.

After the adequate induction of anesthesia the patient is positioned in the prone position. A midline incision is made, the appropriate unilateral lamina is radiographically identified and exposed, and a unilateral hemi-laminotomy is performed preserving facet stability. A complete discectomy is performed, and the superior and inferior endplates are exposed. The lumbar plate insertion gun **700** is placed underneath the thecal sac. Fluoroscopic guidance may be used to verify centrality of lumbar disc plate placement. The trigger of the gun **700** is depressed which leads to insertion of the lower lumbar disc plate **100** into the lower vertebra. The lower lumbar disc plate releasing button is depressed which releases the plate from the inserter claws **551** (FIG. **9**B). The second upper plate **100** is now manually driven into the interspace by the gun's **700** manual plate driver (**520**). Because of the design of the gun mechanism as described above, the second plate **100** is now perfectly aligned with the first lumbar disc plate **110**. The gun trigger is depressed, and this drives the upper plate **100** into the upper vertebrae. The upper lumbar disc plate release button is now depressed and this releases the upper lumbar disc plate from the claws of the inserter gun **700**. The gun **700** is removed from the space. An appropriately sized mobile core **150** is now inserted in between upper and lower lumbar disc plates **100**, **110**. The patient is closed routinely.

The current device allows safe placement of lumbar and cervical artificial discs into the spine without intervertebral distraction, and therefore places minimal tension on facet joints. The method of insertion is quick, gentle, and time efficient. The plate insertion gun could potentially be adapted for other inter joint orthopedic devices, and further adaptations may have applications in manufacturing, toy, carpentry and other industries.

What is claimed is:

**1**. An artificial disc system comprising:

an artificial disc comprising:

first and second plates formed to occupy a space defined by vertebral endplates of a spine, each of the first and second plates including an endplate-engaging surface having plurality of anchors and a core-engaging surface positioned opposite the endplate-engaging surface, wherein the plurality of anchors on the endplate-engaging surface of the first plate comprise a first group of at least three anchors on a left side of the first plate and a second group of at least three anchors on a right side of the first plate with a middle portion of the first plate having no anchors between the first and second groups of anchors, wherein the plurality of anchors on the endplate-engaging surface of the second plate comprise a third group of at least three anchors on a left side of the second plate and a fourth group of at least three anchors on a right side of the second plate with a middle portion of the second plate having no anchors between the third and fourth groups of anchors, wherein the core-engaging surface of the first plate is substantially concave; and

a mobile core sized and configured to be positioned between the first and second plates to permit the first and second plates to move relative to one another, wherein the anchors on the endplate-engaging surface extend substantially away from the mobile core, wherein the core-engaging surfaces engage first and second plate-engaging surfaces of the mobile core, wherein both of the first and second plate-engaging surface are configured to slide against adjacent core-engaging surfaces of the first and second plate, wherein the first plate-engaging surface of the mobile core has a convex spherical dome portion shaped to mate with the concave core-engaging surface of the first plate, and wherein the mobile core is engaged with the first and second plates such that the first plate can move with respect to the second plate about an x-axis for lateral bending, a y-axis for flexion/extension, and a z-axis for axial spinal rotation, wherein the mobile core is sized large enough to extend partially out of a space defined between the first and second plates when the artificial disc is tiled about the y-axis for flexion/extension.

**2**. The artificial disc system of claim **1**, wherein the convex spherical dome portion of the first plate-engaging surface of the mobile core has a first height and a first radius with first height less than the first radius, wherein the mobile core has a radially outer portion that is positioned radially outward of the convex spherical dome portion, and wherein the core-engaging surface of the first plate has a convex spherical dome portion with a second height and a second radius with the second height less than the second radius.

**3**. The artificial disc system of claim **1**, wherein the mobile core has a first width along the x-axis from a core front to a core back and a second width along the y-axis from a first core side to a second core side, and wherein the second width is equal to the first width.

**4**. The artificial disc system of claim **1**, wherein the mobile core has a first width along the x-axis from a core front to a core back and a second width along the y-axis from a first core side to a second core side, and wherein the second width is at least as great as the first width.

**5**. The artificial disc system of claim **1**, wherein the first and second plates are configured to move with respect to the mobile core to have a substantially parallel orientation as well as a plurality of nonparallel orientations.

**6**. The artificial disc system of claim **1**, wherein the first plate can tilt with respect to the second plate by over 8 degrees with respect to each of the x-axis and the y-axis.

**7**. The artificial disc system of claim **1**, wherein the mobile core comprises a rim configured to engage a projecting portion on at least one of the first and second plates to limit movement of the mobile core with respect to the at least one of the first and second plates.

**8**. The artificial disc system of claim **1**, wherein the artificial disc is sized and configured to be a cervical artificial disc to be inserted in a cervical disc space.

**9**. The artificial disc system of claim **1**, wherein one or more anchors of the first group of at least three anchors, one or more anchors of the second group of at least three anchors, one or more anchors of the third group of at least three anchors, and one or more anchors of the fourth group of at least three anchors are symmetric when viewed along the x-axis.

**10**. The artificial disc system of claim **1**, wherein one or more anchors of the first group of at least three anchors, one or more anchors of the second group of at least three anchors, one or more anchors of the third group of at least three anchors, and one or more anchors of the fourth group of at least three anchors are symmetric when viewed along the z-axis.

**11**. The artificial disc system of claim **1**, wherein one or more anchors of the first group of at least three anchors, one or more anchors of the second group of at least three anchors, one or more anchors of the third group of at least three anchors, and one or more anchors of the fourth group of at least three anchors are symmetric when viewed along the y-axis.

**12**. The artificial disc system of claim **1**, wherein the endplate-engaging surface of the second plate is flat between the third group of at least three anchors and the fourth group of at least three anchors.

**13**. The artificial disc system of claim **1**, wherein the endplate-engaging surface of the second plate has no raised surface features between the third group of at least three anchors and the fourth group of at least three anchors.

**14**. The artificial disc system of claim **1**, wherein the anchors comprise spikes.

**15**. The artificial disc system of claim **1**, wherein the mobile core comprises means to limit movement of the mobile core with respect to at least one of the first and second plates.

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